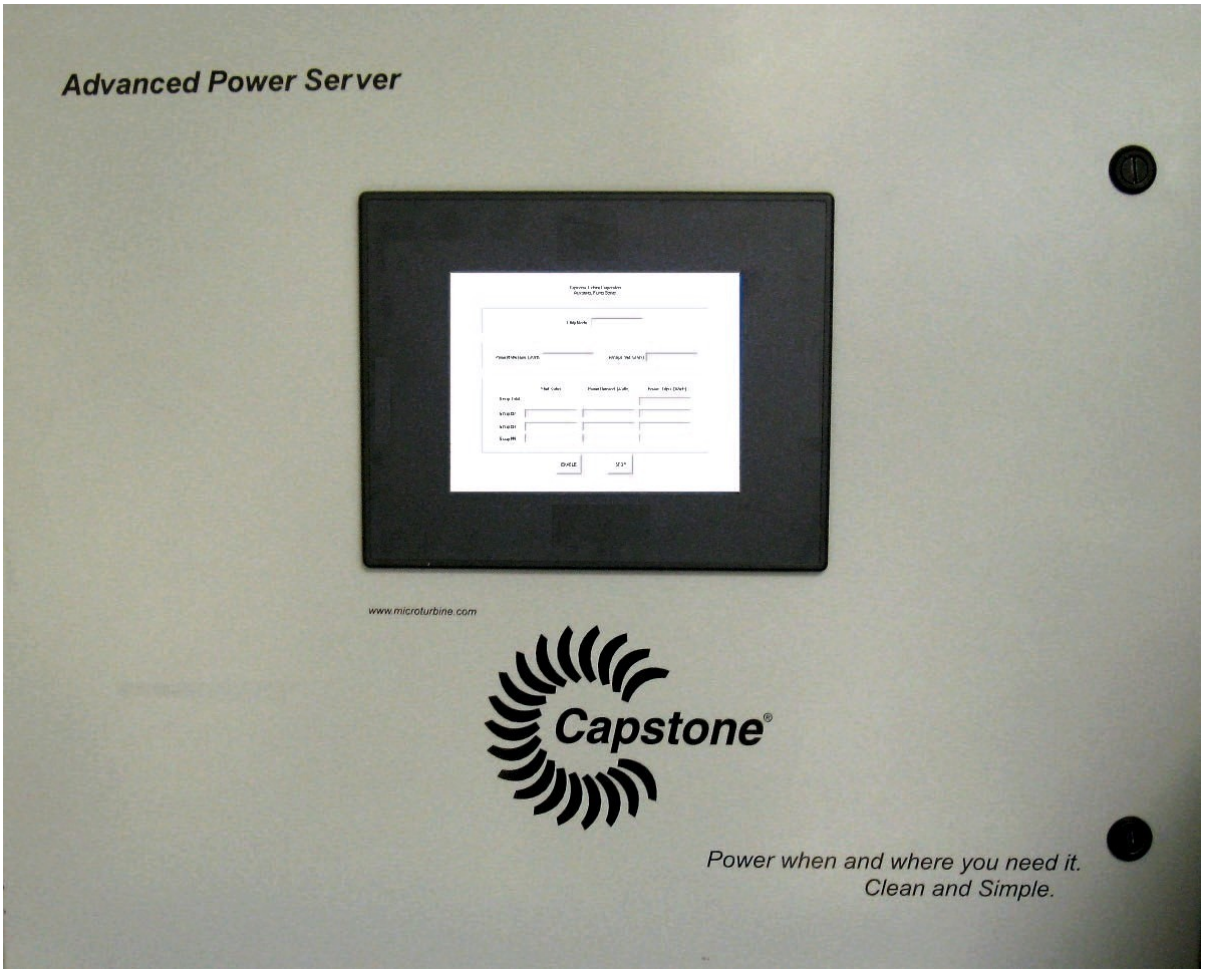
CAPSTONE TURBINE CORPORATION

ADVANCED POWER SERVER (APS)

USER'S MANUAL



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PRODUCT OVERVIEW

Introduction

The Capstone Advanced Power Server (APS) is the second-generation MicroTurbine multi-unit controller manufactured by Capstone (internal view in Figure 1). Its primary purpose is to provide advanced control capability that allows groups of C60 and/or C65 MicroTurbines to operate with all the benefits of both a collection of individual units and a single aggregate unit. With the addition of an APS, the functionality of a group of Capstone MicroTurbines is significantly improved and inherently more reliable compared to a MicroTurbine MultiPac system without a dedicated controller. In addition to the APS' enhanced MultiPac control functionality this second-generation power server has two other significant features built into it.

The first new feature is the ability to communicate with a Building Management System (BMS) as well as read data from Modbus compatible field devices. The APS can interface with an existing BMS controller over an RS485 Modbus two-wire network, where the APS is a slave device with a fully software configurable register map. The APS can also act as a master on a RS485 Modbus two-wire network that is completely independent from the incoming RS485 network. On this network, the APS can connect to multiple Modbus slave devices to provide local monitoring and control for balance of plant equipment, such as reading electric power meters, water flow meters, gas meters, etc. This network is internally connected to a PLC that is custom programmed by Capstone for the individual customer's site needs. In addition, this internal PLC has the ability to interface with digital voltage I/O, analog voltage I/O, analog current I/O, and analog temperature inputs, giving the APS the ability to handle a variety of needs a customer may require.

The second new feature in the APS is the optional built in remote monitoring capability. This allows the APS to become part of an internet-based remote data monitoring, alarming, and trending service offered by Capstone. The Capstone Service Network (CSN) allows users to monitor their MicroTurbines and other Balance Of Plant (BOP) devices that are controlled by the APS from a customer's site specific web page accessible from the Internet. When an alarm condition occurs, the user receives an e-mail notification alerting him/her of the issue. This new remote monitoring functionality also allows Capstone a remote connection that will provide diagnostic and software update capability from the main corporate customer service center.

Figure 1. Internal Views of an APS Unit with Remote Monitoring Hardware

PRODUCT INTERFACE DEFINITION

APS Mechanical Connections

All APS connections are made through a conduit that enters the cabinet from the bottom. This includes all control signal connections, communication connections, and primary power connections. The primary power connection is on the left side inside the cabinet and the control wiring connections are on the right side of the inside of the cabinet on the terminals along the bottom as shown in Figure 2. Also detailed in Figure 2 are the LAN and optional internet connection locations. For details of terminal connection points, see the APS Installation Specification (480024).

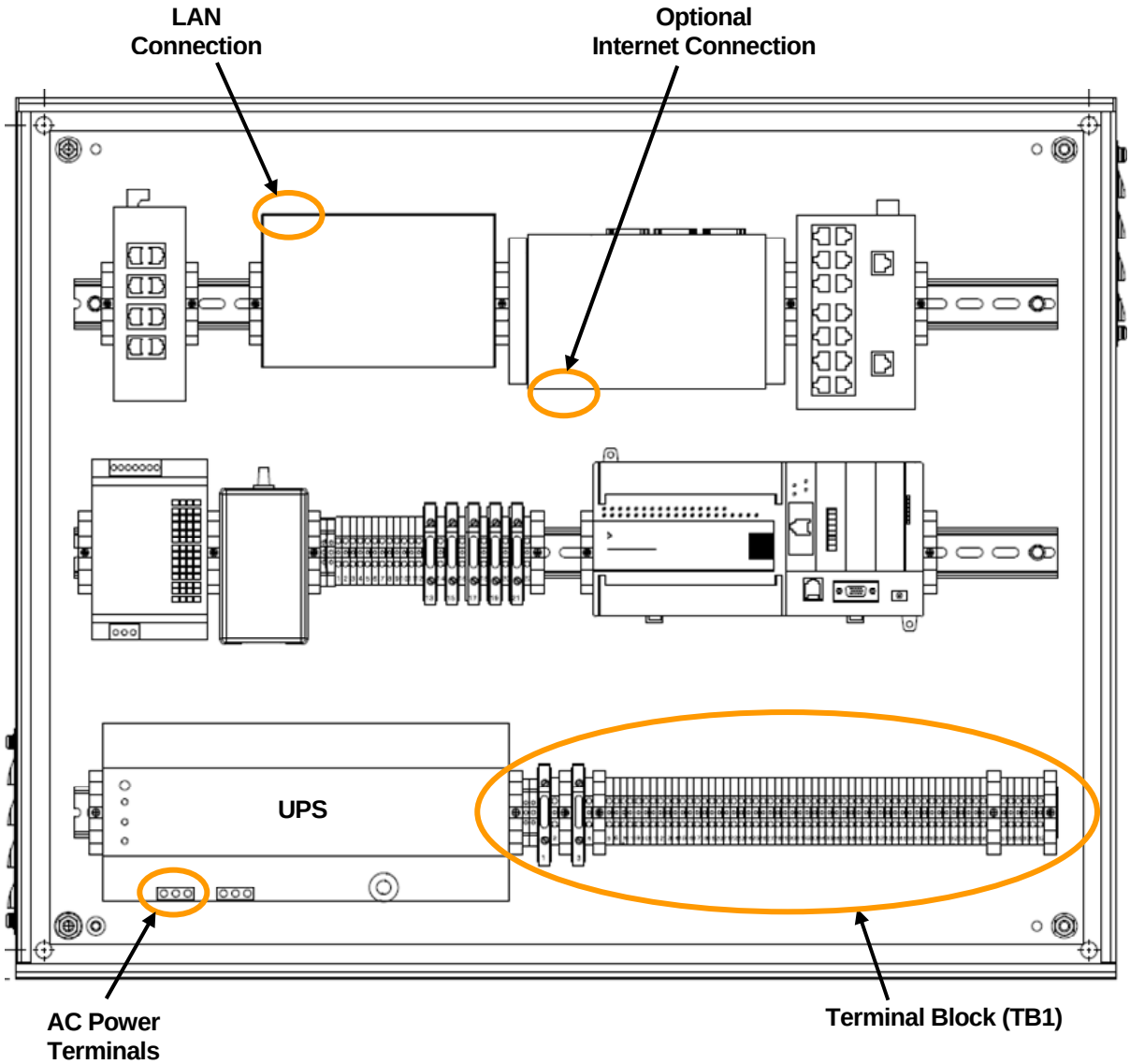


Figure 2. APS Connection Terminals

APS Human Interface

Front Display

The front touch screen display on the APS provides basic operational information and overall APS on/off control for the four potential groups. When operating in a Grid Connect configuration, the view is of the three Grid Connect groups along with the total power summation of all three Grid Connect groups as shown in Figure 3 below. During Stand Alone operation, the third section in Figure 3 will automatically change from displaying Group Total, Group #2, Group #3, and Group #4 to displaying Group #1. This happens when a Dual-Mode system transfers due to loss of grid power or if the system is permanently setup for Stand Alone operation. Along with all the informational data boxes on the display, there are two control buttons that enable or stop the operation of the entire APS controller and all turbines under its control. When either button is pressed, a confirmation window will appear confirming the request prior to executing the command. This avoids any false startup or shutdowns due to accidentally bumping of the touch screen. Details of the information contained in all of the data boxes in Figure 3 are described in Table 1.

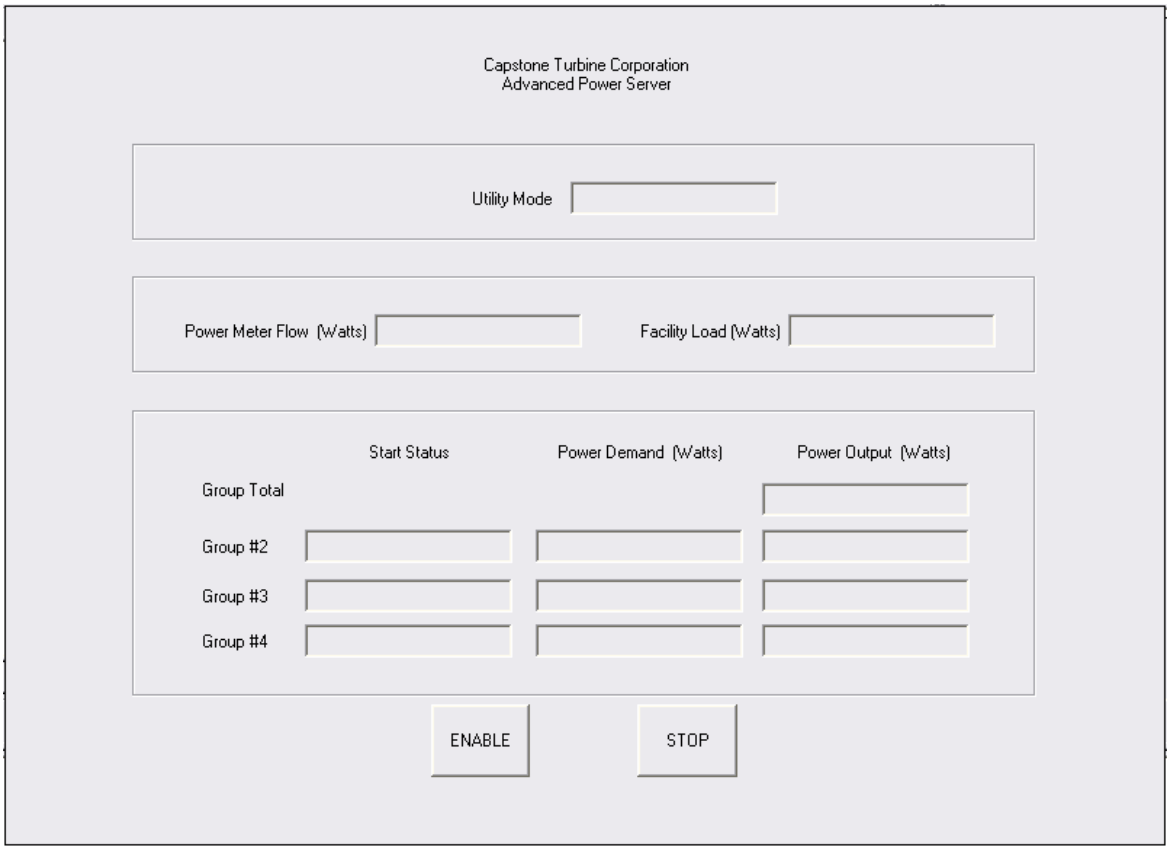


Figure 3. APS Grid Connect Operation Front Display Panel

Table 1. APS Display Data Description

Display Label	Display Data Description
Utility Mode	Utility Connection status of the APS controller (Stand Alone or Grid Connect).
Power Meter Flow (Watts)	Current power meter reading if the use of a meter is selected for the active utility mode.
Facility Load (Watts)	Current power consumption of power meter facility downstream. Will appear blank if the use of a meter is not selected for the active utility mode
Group Total Power Output (Watts)	Power output summation of Group # 2, #3, and #4 (Only viewable in GC mode).
Groups 1 to 4 Start Status	Operational Status of turbine Group # 1 to #4. (Can be on or off.)
Groups 1 to 4 Power Demand (Watts)	Current power demand of turbine Group # 1 to #4.
Groups 1 to 4 Power Output (Watts)	Current power output of turbine Group # 1 to #4.

APS-CRMS Computer Software Program

All configuration and control of the APS is achieved through a version of PC software with the name APS-CRMS which is included with the APS product. This software also includes all the functionality of the existing Capstone Remote Monitoring Software (CRMS) product that allows direct communication with Capstone MicroTurbine products. For a description of the software functionality that is not specific to the APS application, refer to CRMS Technical Reference User Edition (410013).

APS-CRMS Software Installation

This PC software is included on the CD that is inside the APS. The first step prior to installing this software is to choose the computer where the software is to be installed. Confirm the computer meets the minimum requirements that are listed in the Specification section of this document, and connect on the same LAN as the APS. If the APS will not be locally networked, then extra steps must be performed to directly connect a computer to the APS. You will need to reconfigure your computer's TCP/IP connection settings that are available under the Network Connection Settings menu. First, disconnect any network cables to the computer you are using and directly connect its network connection to the APS LAN port. Once this is done, you can change your computer's networking TCP/IP settings to use a static IP address and subnet mask as defined below:

- IP Address: 198.1.1.1 (can be any number other than the address of the APS)
- Subnet Mask: 255.255.0.0

Now you may plug the computer directly into the APS LAN connection port with an Ethernet RJ45 cable.

To install this software, simply remove the CD from the APS cabinet and insert in the chosen computer. From the Run directory choose the APS-CRMS_Install.exe icon on the CD to begin installation. Follow the step-by-step instructions to complete the installation. Once the software is installed, launch the APS-CRMS program and enter the IP address of the APS that was provided to Capstone from the customer (this address was programmed into the APS at the factory) into the TCP/IP textbox on the APS (as shown in Figure 5) to allow APS-CRMS PC software to establish communication with the APS.

APS-CRMS Software APS Associated Screens

Figure 4 shows the link button (also available on the Advanced Power Server menu item selection from the Window drop-down menu) to the APS section of APS-CRMS program. When the program is first started, this link is automatically started to bring up the APS interface in the APS-CRMS program. Once in the APS section of the APS-CRMS software, you will be able to access all the available windows for APS configuration and control.

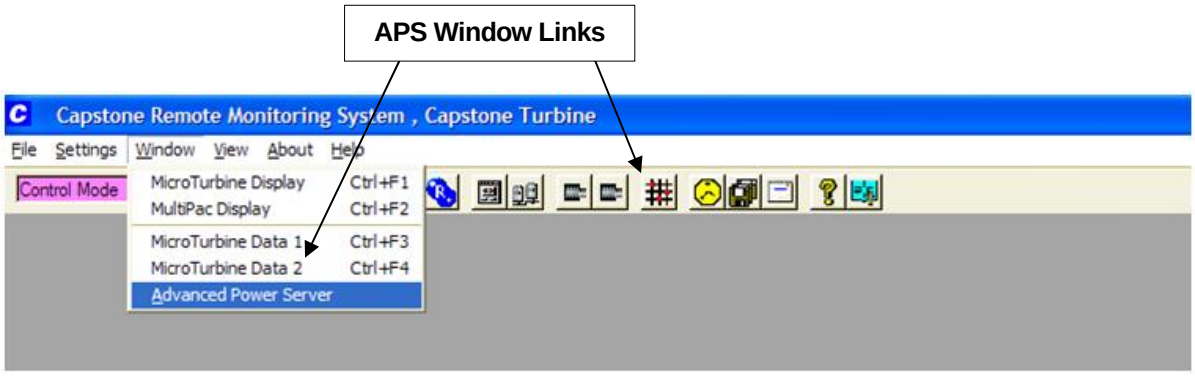


Figure 4. APS User Windows Links in APS-CRMS Program

The APS section of the APS-CRMS software has two access levels available as shown in Table 2. The first is the User Level that allows the user to monitor his system and make lower level setup changes to his system. The second is the Administration Level that is accessible by Capstone authorized service providers for accessing higher level configuration settings. All passwords are entered in the password textbox of the Advanced Power Server Configure window as shown in Figure 5.

Table 2. APS Password Levels

Password Level	Password
User Level	usr123p
Administration Level (ASP)	Contact Capstone Customer Service

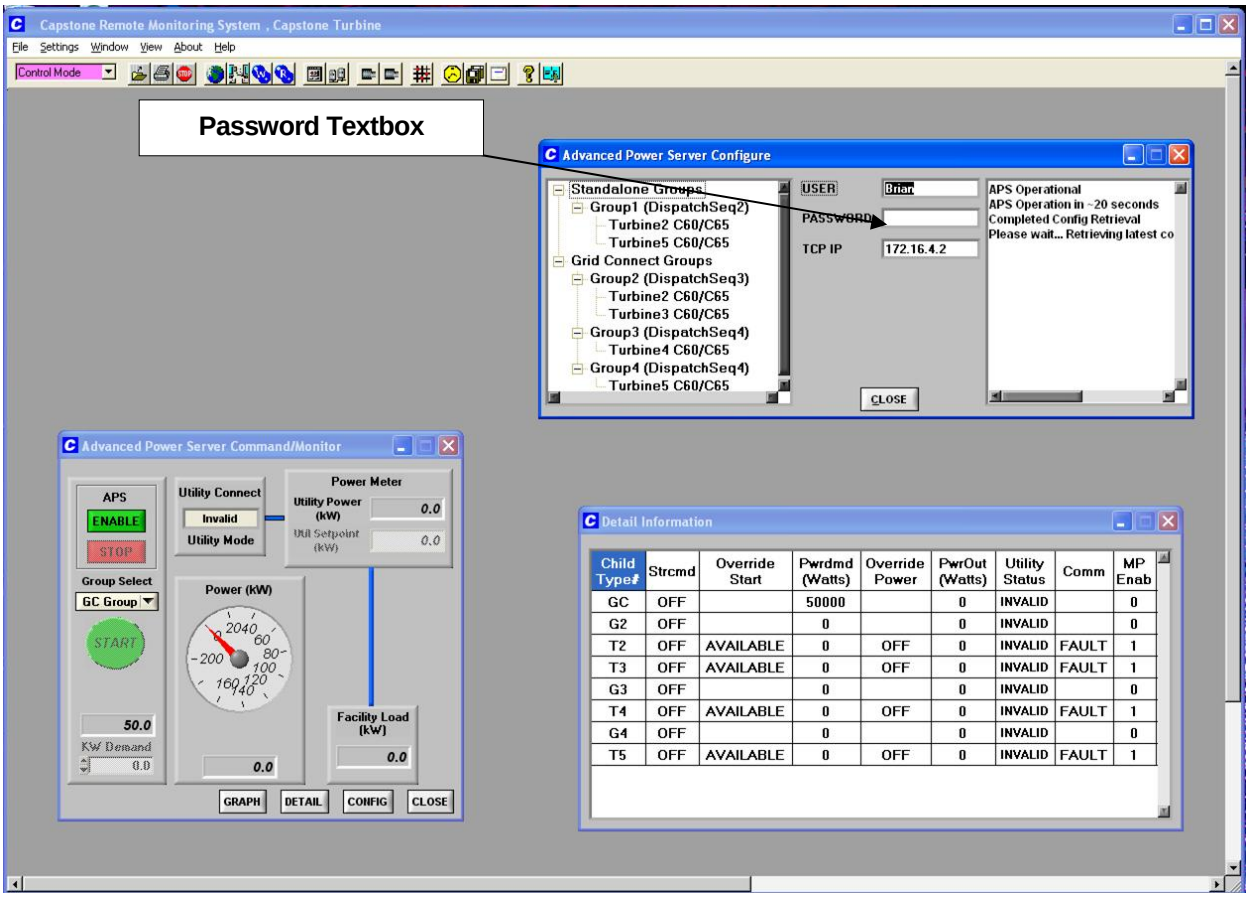


Figure 5. Password Entry Textbox Location

Figure 6 shows the overview of all the APS-CRMS windows that exist for user and administration setup and monitoring. Windows with the placeholder variables of "X" (shown in the figure) may contain the numbers 1, 2, 3, or 4 representing one of the four possible groups of MicroTurbines that are allowed. Windows with the placeholder "Y" represent 2, 3, and 4 in the default configuration, however, you can also create new settings to assign the next available number in the series. Also highlighted in Figure 6, are the windows associated with a group's dispatch configuration setup. This setup controls how the group as a whole operates and the windows associated with the group's turbine configuration setup. The turbine configuration setup controls programming the individual turbines within a group with matching settings to ease setup. The light grey area highlights the settings that are only changeable from the administration level.

Table 3 describes how to open any of the windows shown from the parent windows which represent the lines in Figure 6. To close any of the windows shown in the diagram either use the "CLOSE" or "BACK" buttons that are available on the various windows or their parent windows.

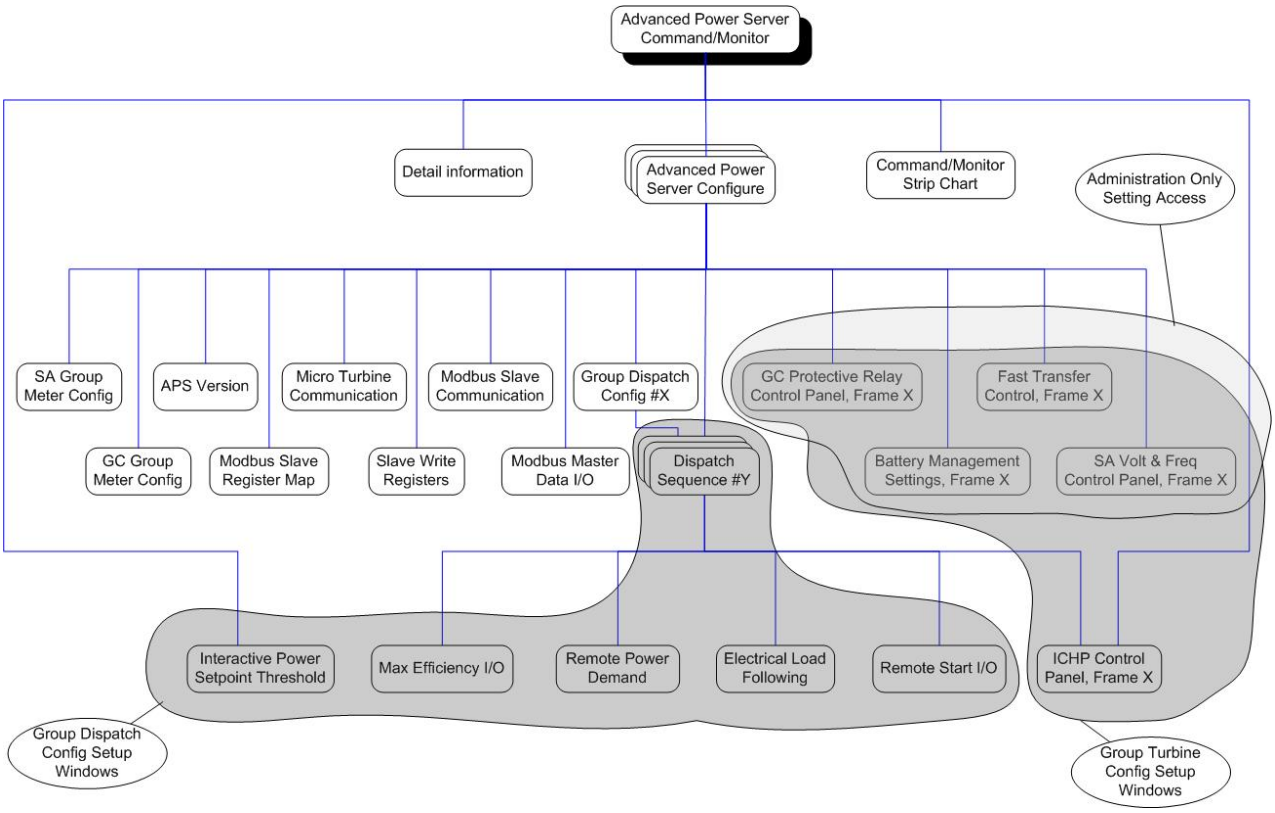


Figure 6. APS-CRMS Software Windows Tree Structure

Table 3. APS Windows Opening Method

Window Name	Open Method
Advanced Power Server Command/ Monitor	Automatically at program launch. Through Link buttons shown in Figure 4.
Command/Monitor Strip Chart	Graph button on Advanced Power Server Command/Monitor window
Detail Information	Automatically at program launch. Detail, iCHP or Graph button on Advanced Power Server Command/ Monitor window.
Advanced Power Server Configure	Click the Config button on Advanced Power Server Command/Monitor window (once password has been entered correctly in the Advanced Power Server Configure window)
Dispatch Sequence #Y	From the Advanced Power Server Configure window (when in Configuration mode) double click the "Group/Turbine Setup" option in the left side of Advanced Power Server Configure window. Then double click the "GroupX (DispatchSeqY)" option to access the associated dispatch sequence listed. From the Group Dispatch Config #X window: Click on the "Edit Dispatch Sequences" button on the right top of this window.

Window Name	Open Method
APS Version	When in Configuration mode, double click the "APS Version/Log" option in the left side of Advanced Power Server Configure window.
SA Group Meter Config	When in Configuration mode, double click "Group/Turbine Setup" in the left side of the Advanced Power Server Configure window, then highlight (single click) "Standalone Groups" and select the "Edit Meter Config" option from the top drop-down menu in the middle of the Advanced Power Server Configure window.
GC Group Meter Config	When in Configuration mode, double click "Group/Turbine Setup" in the left side of the Advanced Power Server Configure window, then highlight (single click) "Grid Connect Groups" and select the "Edit Meter Config" option from the top drop-down menu in the middle of the Advanced Power Server Configure window.
Group Dispatch Config #X	When in Configuration mode, double click "Group/Turbine Setup" in the left side of the Advanced Power Server Configure window, then highlight (single click) one of the four groups that you want to setup and select the "Edit Group Dispatch Config" option from the top drop-down menu in the middle of the Advanced Power Server Configure window.
Battery Management Settings, Frame X	When in Configuration mode, double click "Group/Turbine Setup" in the left side of Advanced Power Server Configure window, then highlight (single click) one of the four groups that you want to setup and select the "Edit Group Turbine Config" option from the top drop-down menu in the middle of the Advanced Power Server Configure. Once this is done the top menu will change and you can then select the "Battery Management" option from the same drop-down menu
GC Protective Relay Control Panel, Frame X	When in Configuration mode, double click "Group/Turbine Setup" in the left side of Advanced Power Server Configure window, then highlight (single click) one of the four groups that you want to setup and select the "Edit Group Turbine Config" option from the top drop-down menu (in the middle of the Advanced Power Server Configure window). Once this is done, the top menu will change and you can then select the "GC Protective Relay" option from the same drop-down menu.
SA Volt & Freq Control Panel, Frame X	When in Configuration mode, double click "Group/Turbine Setup" in the left side of Advanced Power Server Configure window, then highlight (single click) one of the four groups that you want to setup and select the "Edit Group Turbine Config" option from the top drop-down menu (in the middle of the Advanced Power Server Configure window). Once this is done, the top menu will change and you can then select the "SA Volt & Freq Settings" option from the same drop-down menu.
Fast Transfer Control, Frame X	When in Configuration mode, double click "Group/Turbine Setup" in the left side of Advanced Power Server Configure window, then highlight (single click) one of the four groups that you want to setup and select the "Edit Group Turbine Config" option from the top drop-down menu in the middle of the Advanced Power Server Configure window. Once this is done, the top menu will change and you can then select the "Fast Transfer Settings" option from the same drop-down menu.
Modbus Slave Register Map	When in Configuration mode, double click "Slave Register Map" in the left side of Advanced Power Server Configure window.
Master Data I/O	When in Configuration mode, double click "Master Data I/O" in the left side of Advanced Power Server Configure window.

Window Name	Open Method
Slave Write Registers	When in Configuration mode, double click "Slave Write Registers" option in the left side of Advanced Power Server Configure window.
Modbus Slave Communications	When in Configuration mode, double click "Modbus Slave" in the left side of Advanced Power Server Configure window.
MicroTurbine Communications	When in Configuration mode, double click "MicroTurbine" in the left side of Advanced Power Server Configure window.
Max Efficiency I/O	When in Configuration mode, click "Max Efficiency" checkbox in the Power Dispatch section of the Dispatch Sequence #Y window.
Interactive Power Setpoint Threshold	From the Advanced Power Server Command/Monitor window, click the "PWR SETPT" button on the bottom left of this window if the selected group power dispatch sequence is configured for Power Setpoint operation in the Power Dispatch section.
Remote Power Demand	When in Configuration mode, click the "Remote" checkbox in the Power Demand section of the Dispatch Sequence #Y window.
Electrical Load Following	When in Configuration mode, click the "ELF" checkbox in the Power Demand section of the Dispatch Sequence #Y window.
Remote Start I/O	When in Configuration mode, click the "Remote" checkbox in the Start section of the Dispatch Sequence #Y window.
iCHP Control Panel, Frame X	From the Dispatch Sequence #Y window, when in Configuration mode, click the "iCHP" checkbox in the Power Demand section of the Dispatch Sequence #Y window. From the Advanced Power Server Command/Monitor window, click the "iCHP" button on the bottom left corner of this window if the selected group dispatch sequence is configured for iCHP in the Power Demand section.

Remote Monitoring Access through MyMicroturbine.com

For APS products that were ordered with the optional Capstone Service Network (CSN) monitoring capability, there will be a customer specific web page interface available on the World Wide Web. A customer will be given a user name and password to allow them access to their personal site web page for monitoring, trending and alarm tracking. Details of this interface are available in the Capstone CSN User's Manual (400016).

PRODUCT OPERATION

All operational control of the APS product, except the APS ENABLE/STOP buttons on the front panel, is through the APS-CRMS computer software interface that was outlined above. The sections below will identify how to setup an APS configuration and how to use the software to continually monitor and operate an APS.

The APS is designed to run either as a Stand Alone generator controller with all turbines in a single group, as a Grid Connect generator controller with all turbines in one to three groups or as a Dual-Mode fast transfer generator controller with all turbines in one to three groups in Grid Connect operation and some number of the total turbines in a single group in Stand Alone operation.

Figure 7 shows the APS Configuration window with the Group/Turbine Setup view active where Group 1 is the Stand Alone group and Groups 2, 3, and 4 are the Grid Connect groups. This is the permanent structure of the APS grouping and the user just needs to assign turbines to each group as required. Figure 7 has been set up as a Dual-Mode system because it has turbines under both Grid Connect and Stand Alone groups. This example also shows the flexibility to have turbines from different Grid Connect groups as members of the Stand Alone group. Please keep in mind that each individual turbine needs to be setup to match this structure by configuring the individual turbine directly to be Stand Alone, Grid Connect, or Dual-Mode and to be Multipac enabled.

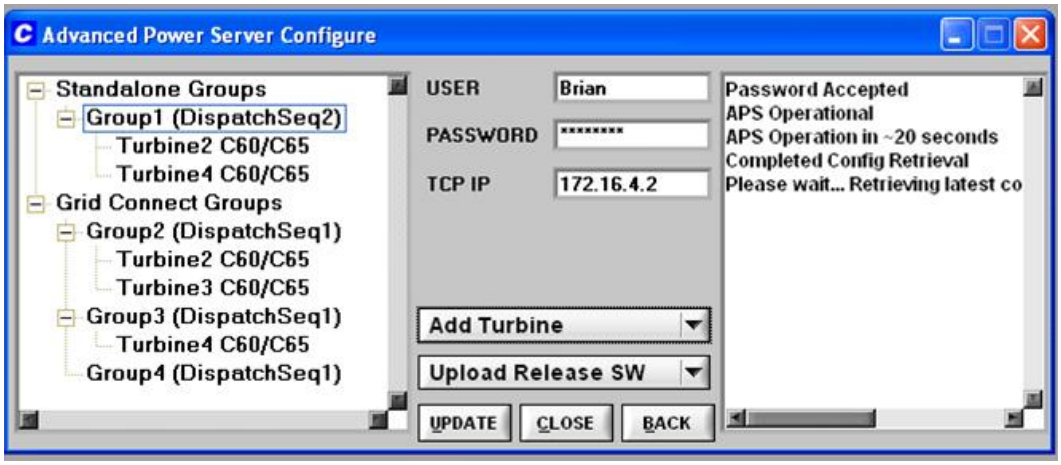


Figure 7. APS Grouping Structure

General Monitoring and Command Control

There are three windows that are primarily for monitoring the operation of MicroTurbine groups in the APS-CRMS PC software. They are the Advanced Power Server Command/Monitor window, the Command/Monitor Strip Chart window, and the Detail Information window as shown in Figure 8. The APS Command/Monitor and Command/Monitor Strip Chart windows are linked to a particular group or group type and that group or group type is selected from the Group Select drop-down menu on the APS Command/Monitor window. The Detail Information window is not group specific and shows all turbines for the groups in the current active utility connect mode.

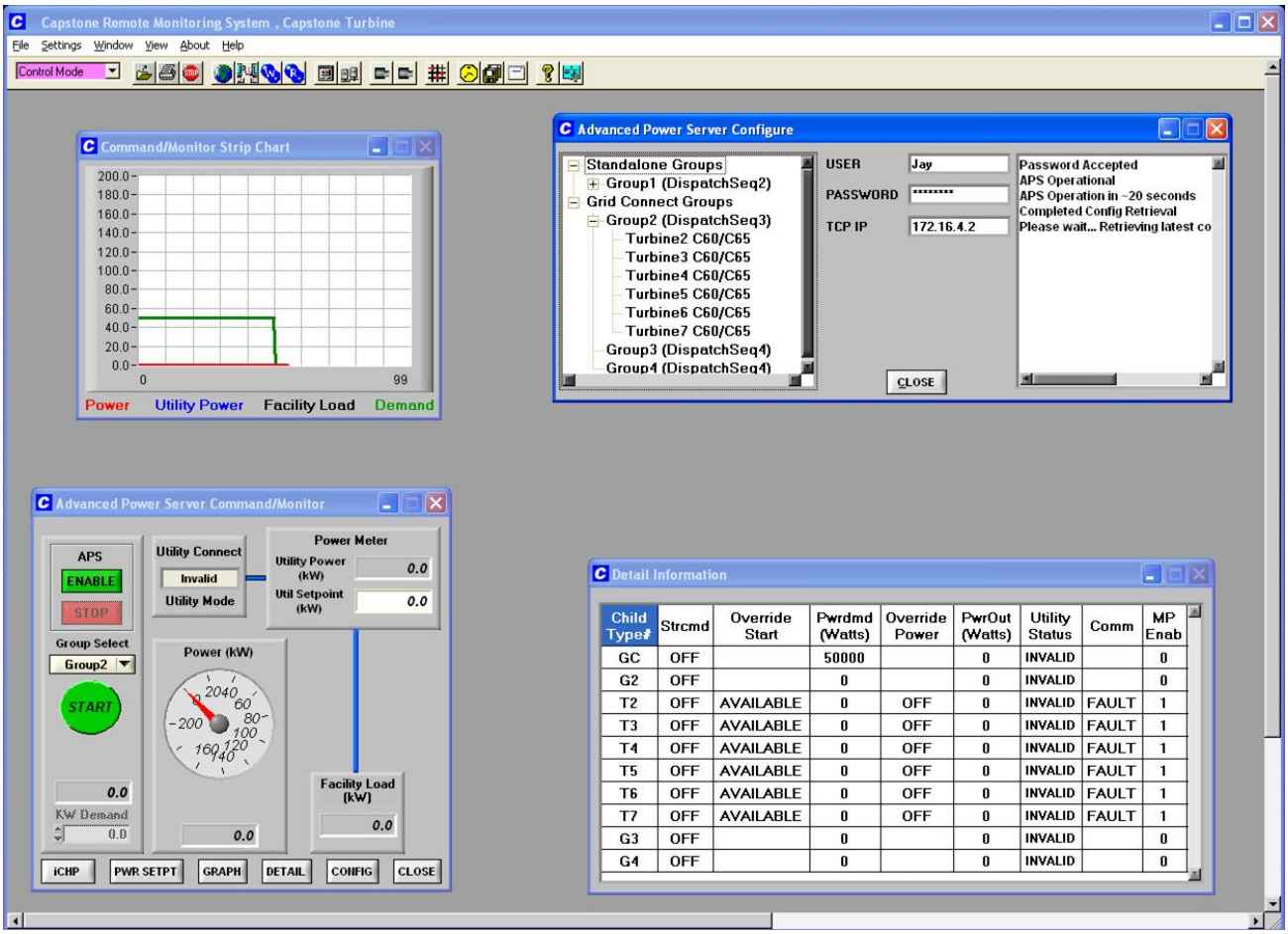


Figure 8. Windows Associated with APS Monitoring and Operation

Advanced Power Server Command/Monitor Window

This window is the primary window used for commanding and monitoring the APS controller through the APS-CRMS software and will remain open unless you exit the APS portion of the APS-CRMS software. From this window you can jump to all other windows that are associated with APS-CRMS program by using the buttons available along the bottom. You can also exit out of the APS section of the APS-CRMS software by clicking the CLOSE button on the bottom right of this window.

The left side of this window is the section that has the primary controls functionality. The list below describes each item in the left of the APS command/monitor window and its functionality.

- **APS Enable button**:
  A control button that will allow the APS to operate all groups of turbines (as you have previously configured them to run).
- **APS Stop button**:
  A control button that will immediately perform a normal shutdown of all turbines in all groups regardless of the current status or configuration of the groups and does not allow a restart until the APS has been re-enabled.

- **APS Group Select drop-down menu:**
  A drop-down menu that lets you to select the group or group category that the data in this window and the Command/Monitor Strip Chart window displays and acts on with commands. If the SA or GC group categories are chosen, all setting inputs will be grayed out and you can only view the feedback data of the cumulative of the turbine groups in that group category.
- **Start/Stop button:**
  A manual start/stop input for the selected group. For a given group, this must be enabled before the group is allowed to start regardless of group configuration.
- **Power demand feedback data textbox (unlabeled data box):**
  This textbox is an actual real-time power setpoint of the selected group.
- **User input kW Demand selection box:**
  A manual user power demand input for the selected group. The group configuration must be associated with a dispatch sequence where the Power Demand setting is set to user for this input to be active.

In the middle of the APS Command/Monitor window is the Power Output dial and textbox display. This will display the real-time power output of the current group or group category that is selected. On the top middle of this window is the Utility Connect/Utility mode display textbox. This informational textbox will display the current status of the Utility connection of the APS. The options are Grid Connect (GC), Stand Alone (SA), or Invalid. When in GC mode, all three GC groups can run if configured. If in SA mode, the SA group can be operated if configured to do so. The Invalid mode will be active if the APS has not been set up, is not set up correctly, or is currently transitioning between GC and SA on a Dual-Mode system.

On the right side of the APS Command/Monitor window are two sections that display information for an APS that has a power meter connection setup for its use. Both the Power Meter and Facility Load sections that are on the top and bottom of the right side of the APS Command/Monitor window respectively will only show up if the Use Meter checkbox is selected in the Grid Connect Edit Meter Configuration window. Below are the descriptions of each of the three data/input boxes.

- **Power Meter, Utility Power (kW)**:
  Power flowing through a power meter if one is present.
- **Power Meter, Utility Setpoint (kW)**:
  If the selected group is configured for load following, this input box will be accessible to allow you to set the amount of power coming from the utility feed that the selected group will try and regulate.
- **Facility Load (kW)**:
  Summation of the utility power reading and the output power of all the running turbines regardless of the groups they belong to.

Command Monitor Strip Chart Window

This window plots four data items on a graph at the same time, to allow you to see what is happening with the group that is selected on the group select drop-down menu located on the APS configure/monitor window. The data displayed is:

- Group Output Power (kW)
- Utility Input Power (kW) (if a meter is present and associated with this group*)*
- Facility Load (kW) (if a meter is present and associated with this group*)*
- Group Power Demand (kW)

This window allows you to visually track power being consumed, power being generated and power being purchased if he has set up the group he is currently viewing to use a power meter.

Detail Information Window

The Detail Information window is setup to allow you to retrieve critical information and perform manual control override of any of the turbines that are being controlled by the APS. This information is shown for all groups that you have set up at the same time for a given Utility Connect mode as can be seen in Figure 8. The next two sections describe each item available in the columns that provide status information and the columns that allow input commands.

Detail Information Window Status Columns

The first column in the Detail Information window is a listing of the groups and individual MicroTurbines that are currently setup and active for a given APS utility connection. Table 4 below identifies and lists all of the status column headings along with a description of each.

Table 4. Detail Information Window Status Column Descriptions

Column Heading	Description
Strcmd	Status of the MicroTurbine or Groups start command (on/off).
Pwrdmd (Watts)	Value of the MicroTurbine or Groups commanded power demand.
PwrOut (Watts)	Value of the MicroTurbine or Groups current operating power output.
Utility Status	Status of the MicroTurbine or Groups utility connection (GC/Invalid/SA).
Comm	Status of the MicroTurbine fault or communication status with APS controller.
MP Enab	Status of the MicroTurbine MultiPac enable setting.

Detail Information Window User Settable Columns

There are two columns in the Detail Information window that provide you the ability to command the start and power setting of a MicroTurbine at any given time, regardless of the groups configuration that it is associated with. These columns are labeled Override Start and Override Power.

- **Override Start**

  The Override Start column is set up to allow you to click on the individual MicroTurbine's input box and edit the setting. When you choose this textbox, a drop-down menu will appear at the top of the screen giving him three options as shown in Figure 9. You can either force the unit on, off, or make it available to the APS for use as it has been set up in the group it belongs to.

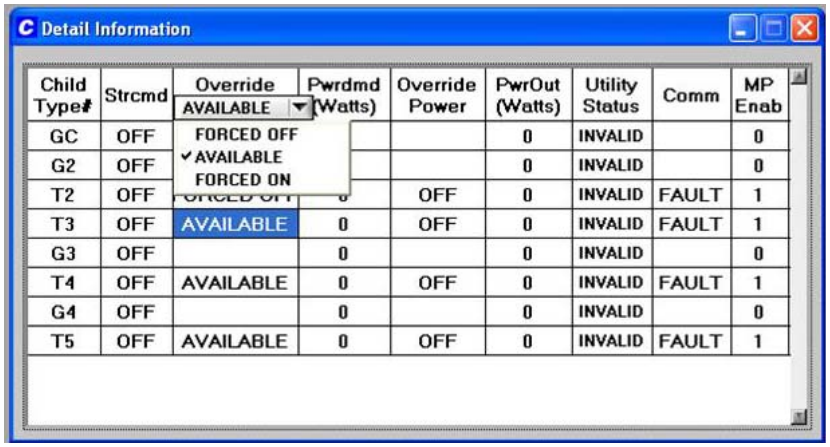


Figure 9. Override Start Column Settings

- **Override Power**

  The Override Power column is setup to allow you to click on the individual MicroTurbine's input box and edit the setting. When you choose this textbox, a drop-down menu will appear at the top of the screen giving two options as shown in Figure 10. If the selection is "OFF", the APS will assign a power demand to the individual unit based on the group that it belongs to. If you choose "ON", the power demand of the unit will be set by you and not changed by the APS. When you set the Override power for an individual unit to "ON", a textbox appears prompting you to input the desired power level that he wants the unit to run at. This unit will maintain this power level until the unit is turned off or until you set the override power setting back to "OFF".

  The Override Power is an independent setting to the Override Start setting and care must be taken because if the override start is left set to "AVAILABLE" the command of the unit on/off is still under the control of the APS controller. If you set the Override Power to a desired value and do not set the Override Start setting to "FORCED ON", the APS controller can still turn off this MicroTurbine if it determines it needs to. Further, the override power is not functional for a Stand Alone system as the load is not adjustable by the generator when operating in this mode.

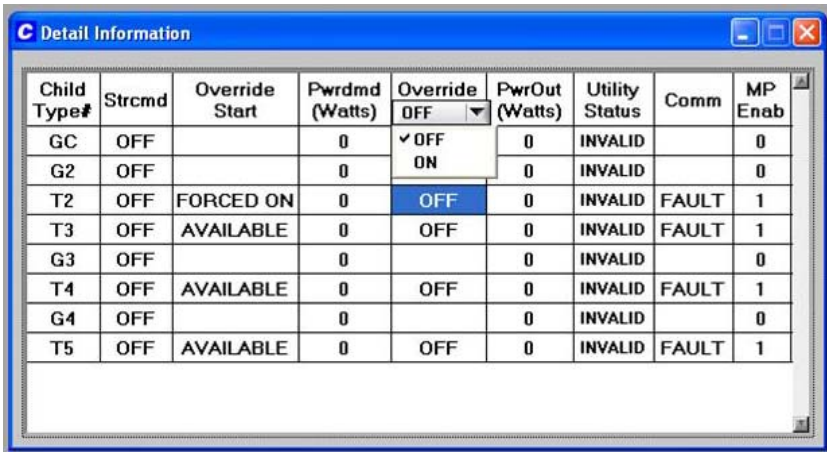


Figure 10. Override Power Column Settings

APS Configuration Setup

All configuration changes are only possible after entering either the user or administration password in the APS Configure window as shown in Figure 5 and then pushing the "CONFIG" button on the APS Command/Monitor window. Once you have done this, the APS configure window will change to look like Figure 11, allowing you to select and modify certain settings based on the password level entered. Settings that require the Administration level access will be identified in the sections below. Each of the following sections describe in descending order a line item in the menu structure in the left section of the of the APS configure window that encompass the totality of the configuration settings available in the APS.

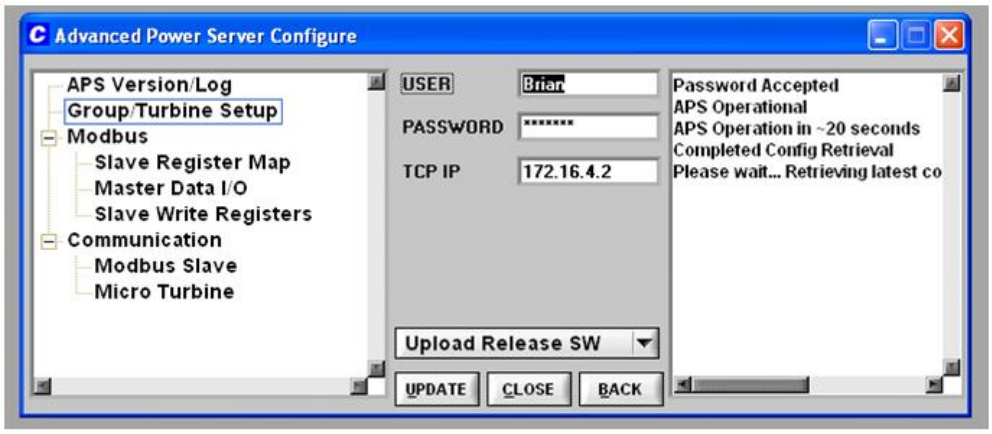


Figure 11. Enabled APS Configure Window Base view

Viewing the Running APS Software Version

To view the running version of the APS Controller Software, open the APS Version window as defined in Table 3. This window (see Figure 12) lists all the running executable programs, dynamic linked libraries, and version, along with the Capstone part numbers that make up the functional APS program on the embedded computer in the APS product.

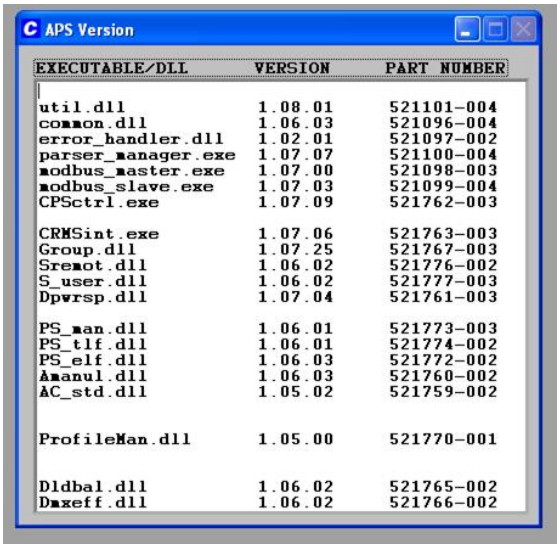


Figure 12. APS Version Window

Configuring a Group Operational Setup

Each group can have a unique operational configuration that is accomplished by creating a Unique Group Turbine Configuration and a unique Group Dispatch Operational Sequence. The group dispatch operational sequence settings are the settings that apply to the group (of turbines) as a whole. These settings are stored on the APS controller and allow it to operate the group as a simulated single generator. The Group Turbine Configuration settings are settings that are sent to each turbines memory by the APS and they allow all the turbines in a single group to operate the same way. These include critical voltage and frequency settings, heat recovery module settings, battery management settings, and Dual-Mode fast transfer configuration settings. All of these settings have to be set the same for units within a group. This eliminates the need to individually configure each turbine in a group directly with the same settings, greatly reducing the system setup complexity and reducing setup time.

Adding and Removing Turbines from a Group

The first step in configuring an APS is to correctly assign turbines to the particular groups you want them in. To change the number of turbines within a group as setup by default, you first need to add or remove turbines by entering into the Group/Turbine Setup view in the APS Configure window. This is done by double clicking the "Group/Turbine Setup" option in the left side of the APS Configure base view window.

Once in the Group/Turbine Setup section of the APS Configure menu, highlight (single click) the group for modification and then select the "Add Turbine" menu item from the upper menu in the APS Configure window as shown in Figure 13. When adding a turbine, you will be prompted to select the number of the turbine you wish to assign to the group. Care must be taken to only assign C60 or C65 turbines that are connected to the APS and have been configured to be the number that was configured in the individual turbine. The turbines are required to be directly configured with a distinct turbine number prior to being connected to an APS. ***Please remember that all turbines must be physically connected to the APS with the proper communication wiring prior to configuring them in software and must never be physically disconnected when the APS is turned on!***

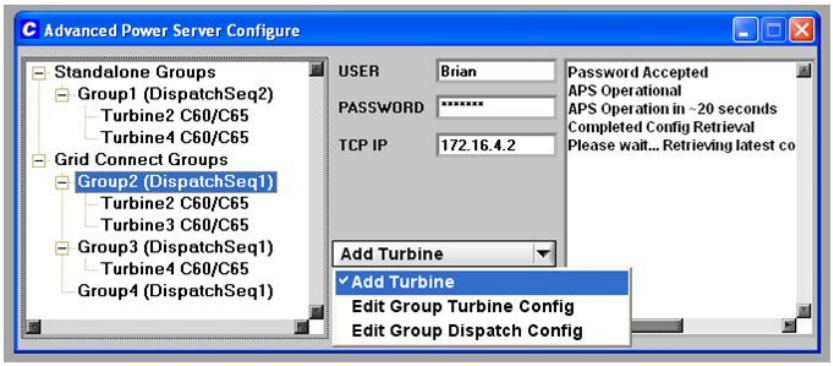


Figure 13. Adding a Turbine to a Group

To delete a turbine, simply highlight the turbine you wish to remove and select "Delete" from the upper menu in the APS Configure window. Continue to add or delete turbines to the group until the number of turbines at your site matches the turbines shown on the left side of the Advanced Power Server Configure window. Once this is complete, you need to press the UPDATE button to locally save this new configuration in the APS-CRMS memory as shown in Figure 14. Any and all changes made to the configuration will require you to press the UPDATE button immediately after the change is made to avoid loosing the change. Care must be taken as the configuration has only been saved within the APS-CRMS program and the APS itself has not yet been programmed with this setup. Details on how to program the APS Controller once all configuration settings are complete will be covered in a later section.

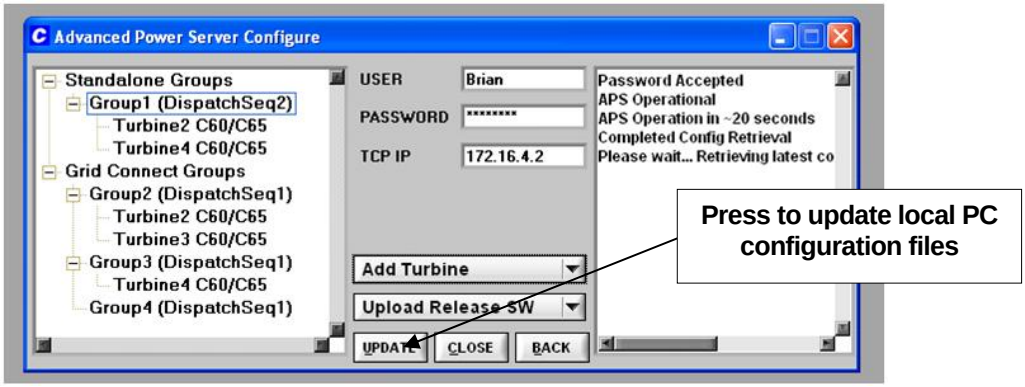


Figure 14. Saving Group Configuration Changes

Configuring the Stand Alone or Grid Connect Groups Power Meter Settings

To initially setup the use of a power meter for either Stand Alone or Grid Connect Groups operation, you first have to configure the settings using the GC and SA Edit Meter Config windows. Access to these windows is described in Table 3. Once you have the window open for the groups settings you want to configure, you will modify the settings shown in Figure 15 for the Grid Connect Groups Meter Configuration window (the Stand Alone Meter Configuration window has the exact same inputs). Details of each of the windows input options are described in Table 5 below.

Figure 15. Grid Connect Edit Meter Config Window

Table 5. GC and SA Group Power Meter Input Item Definition

Input Item (Input category)	Description	Available Settings
Category (Database Select)	Memory Category selection list.	See the table in Appendix 1.
ItemName (Database Select)	Memory item selection list.	See the options in the tables of Appendix 2 that are associated with each group in Appendix 1 Table.
Instance (Database Select)	Selection of entry level for Memory Category that have multiple entries.	Dependant on Memory Category chosen above (See Appendix 1 for details)
Bit Mask (Mask & Polarity)	Bitwise AND with value in the register.	0 to 65535 (Default set to 1, so least significant bit determines start)
ActiveOn (Mask & Polarity)	Inverts the reading in the register.	Positive or Negative (after mask is applied)
Multiplier	Multiplier applied to selected memory value.	Positive or negative integer values
Divisor	Divisor applied to selected memory value.	Positive or negative integer values, but not zero
Use Meter	Activates Use of Meter when operating in the GC or SA mode.	Checked (on) or not-checked (off)

Use of the on/off setting in the GC and SA windows do not have the same outcome. When using the GC setting of the Use Meter checkbox, the setting will remove the Power Meter and Facility Load displays on the APS Command/Monitor window. This same checkbox on the SA window will not affect the APS Command/Monitor window displays. If you want to view any power meter readings when in Stand Alone operation from the APS Command/Monitor window, you must activate the power meter in the GC Meter Configuration window allowing the APS Command/Monitor window displays to be made available.

Associating a Dispatch Sequence to a Group

To assocate a dispatch sequence to a particular group, first select a specific group in the APS Configure window and highlight it. Then choose "Edit Group Dispatch Config" from the middle APS Configure window drop-down menu as shown in Figure 16. Once you make this selection, the Group Dispatch Config window for the chosen group will open as shown in Figure 17. This window is where you associate a given dispatch sequence with the selected group.

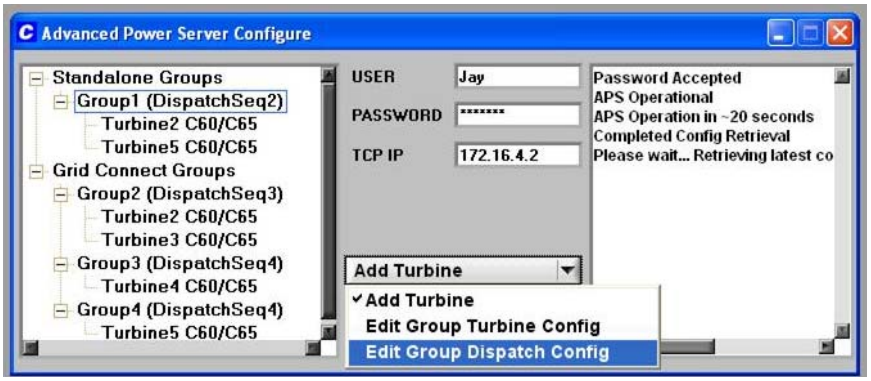


Figure 16. Configuring a Groups Dispatch Sequence

At the top of this window you will see a toggle switch. This switch lets you choose from running a single group dispatch sequence continously or multiple dispatch sequences based on the time and day of the week. If you choose a single dispatch sequence, then the first one chosen will be the one that runs. If you choose to run multiple dispatch sequences for this chosen group of turbines, set the time and day to start the chosen dispatch sequence and then press the update button on the APS Configure window as shown in Figure 14 to save the change. You will still need to upload the changed configuration to the APS controller once all configuration changes are complete.

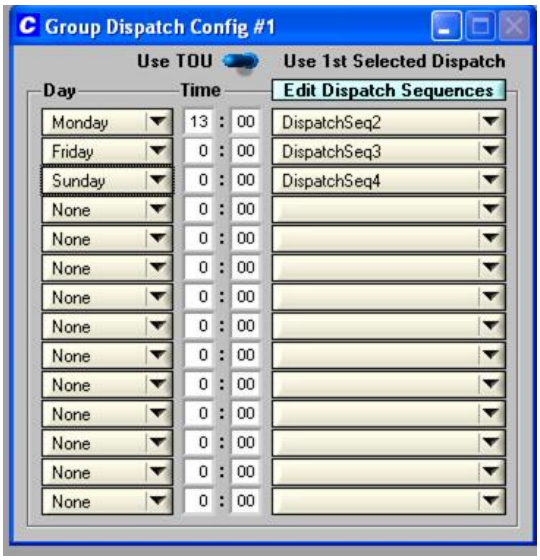


Figure 17. Group Dispatch Config Window

Creating/Deleting Dispatch Sequences

Dispatch sequences are mostly independent of a particular group with the only exceptions being the settings for Power Dispatch and iCHP operation modes. The default APS-CRMS software configuration provides three dispatch sequences that can be assigned to any of the four groups. However, you can also create, modify, or delete dispatch sequences as necessary.

The first step is to open a Dispatch Sequence window as described in Table 3. Once you have a particular Dispatch Sequence window open, you will be able to see the complete list of dispatch sequences in the left side of the APS Configure window as shown in Figure 18. To add a new dispatch sequence, simply choose the "Add Dispatch Seq" option from the upper drop-down menu in the middle of the APS Configure window. To delete a dispatch sequence, simply highlight the one you want to delete from the left side APS configure window and select the Delete option from the same drop-down menu.

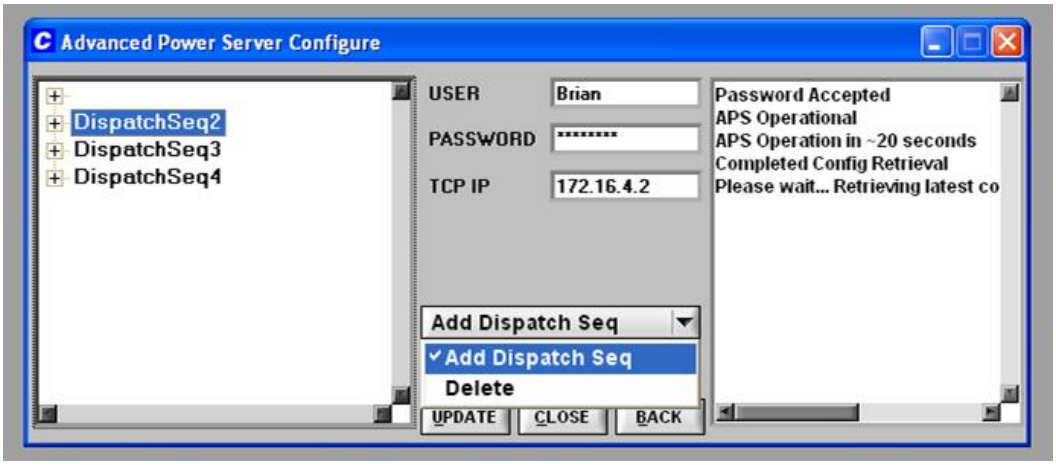


Figure 18. Dispatch Sequence View in APS Configure Window

Once you are done adding/deleting dispatch sequences, you will need to press the "UPDATE" button on the APS Configure window (shown in Figure 14) to save the change. You will still need to upload the changed configuration to the APS controller once all configuration changes are complete.

Configuring a Dispatch Sequence

Configuration of a dispatch sequence is done through the Dispatch Sequences Configuration window that can be accessed as described in Table 3. Figure 19 is an example of that window for the Dispatch Sequence #2. Once you have selected which dispatch sequence you want to configure and opened its window, you will then modify the settings that are grouped into four categories. The four categories (Start, Power Demand, Start Dispatch, and Power Dispatch) are shown in Figure 19 as the headers of the large rectangular borders and will be described in each of their own sections below.

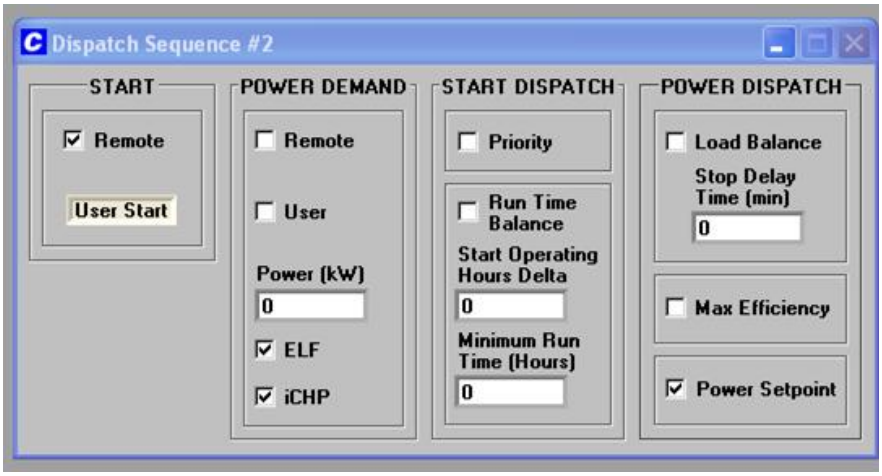


Figure 19. Dispatch Settings Window

Once you finish configuring a particular dispatch sequence, you will need to save your changes by clicking the UPDATE button on the APS Configure window (shown in Figure 14) or your changes will not be saved. You will still need to upload the changed configuration to the APS controller once all configuration changes are complete.

Start Dispatch Sequence Settings

In the Start section of the Dispatch Sequence window, you can change two settings that are related to where a group receives its start/stop command. When the Remote checkbox is checked, the Remote Start I/O window appears, allowing you to configure the location of the remote input signal as seen in Figure 20. This window is separated into two sections, where the upper section defines the input location and the lower section defines any input filtering needed. Details about the options available in each section are shown in Table 6.

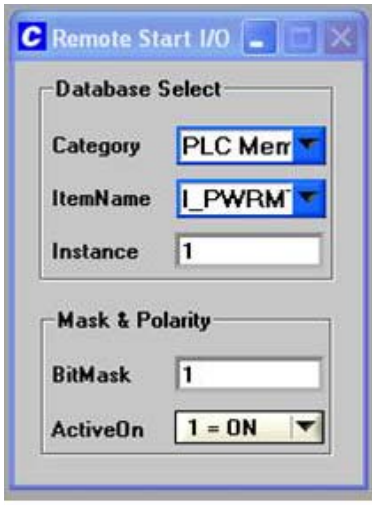


Figure 20. Remote Start I/O Window

Table 6. Remote Start Configuration Window Input Item Definition

Input Item (Input category)	Description	Available Settings
Category (Database Select)	Memory Category selection list.	See the table in Appendix 1.
ItemName (Database Select)	Memory item selection list.	See the options in the tables of Appendix 2 that are associated with each group in Appendix 1 Table.
Instance (Database Select)	Selection of entry level for Memory Category that have multiple entries.	Dependant on Memory Category chosen above. (See Appendix 1 for details.)
Bit Mask (Mask & Polarity)	Bitwise AND with memory value in the register.	0 to 65535 (Default set to 1, so least significant bit determines start.)
ActiveOn (Mask & Polarity)	Inverts the reading in the register.	Positive or Negative (after mask is applied).

The user Stop/Start toggle button at the bottom of the Start section as shown in Figure 19, defines the initial user start or stop command given to the group when a dispatch sequence is initially started. This functionality comes into effect when you set up multiple dispatch sequences for a single group of MicroTurbines using the group dispatch TOU functionality described in the previous section.

Power Demand Dispatch Sequence Settings

The Power Demand section of the Dispatch Sequence window allows you to identify where the power demand input for a group comes from. The remote option is similar to the starts sections remote option, except the settings for the remote power demand are fewer as this is a non-discrete value and does not need the Bit Mask and ActiveOn filtering options. The Remote Power Demand Settings window is shown in Figure 21 with the definitions of the inputs being the same as the first three items defined in Table 6 above.

Figure 21. Remote Power Demand Window

The Power (kW) textbox entry is used to determine the initial setting of the group when a new dispatch sequence is selected to run when using the dispatch TOU functionality for a group. If operating in a mode where you do not set the power demand, this setting will not be used as the start of the dispatch sequence initialization.

There are two other modes of operation which can define the group's power demand. The first one is the Electrical Load Following (ELF) option, where the group of MicroTurbines power setpoint is varied with a control algorithm to regulate the power being imported from the utility. This requires that the site has a power meter at the point of desired regulation of electrical power flow that is communicating to the APS through the Modbus digital communication bus. If a meter is connected and you want to operate using this option, select the ELF option by clicking the ELF checkbox and an Electrical Load Following window appears to allow the setup of the power meter connection. This window is shown in Figure 22 below with the description of each input item in Table 7.

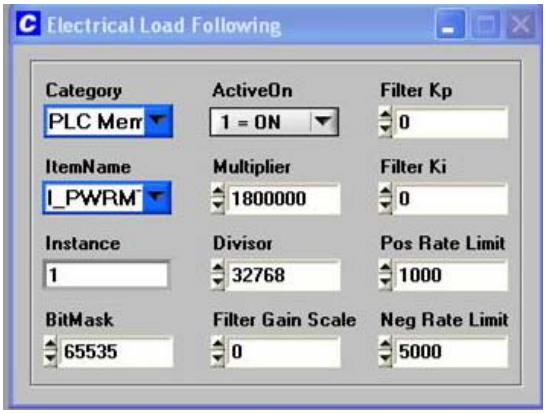


Figure 22. Electrical Load Following Window

Table 7. ELF Window Configuration Input Item Definition

Input Item	Description	Available Settings
Category	Memory Category selection list.	See the Table in Appendix 1.
ItemName	Memory data item selection list.	See the options the tables of Appendix 2 that are associated with each group in Appendix 1 Table.
Instance	Selection of entry level for memory category that have multiple entries.	Dependant on the memory category chosen above. (See Appendix 1 for details.)
BitMask	Bitwise AND with value in the memory.	0 to 65535
ActiveOn	Reverses of sign or the value in memory.	Positive or Negative (after mask is applied)
Multiplier	Multiplier applied to selected memory value.	Positive or negative integer values
Divisor	Divisor applied to selected memory value.	Positive or negative integer values, but not zero
Filter Gain Scale	Input not used/active.	N/A
Filter Kp	Input not used/active.	N/A
Filter Ki	Input not used/active.	N/A

Input Item	Description	Available Settings
Pos Rate Limit	Limits the increasing rate of change of power from the MicroTurbines .	0 to 5000 watts/second
Neg Rate Limit	Limits the decreasing rate of change of power from the MicroTurbines.	0 to 5000 watts/second

The second option for determining the power demand is not a fully independent mode of power demand input because it has to associate to a particular group. Associated with the turbine settings for a group of MicroTurbines is the iCHP operating configuration. If your group is made up of some combination of iCHP units and you select the iCHP power demand checkbox, the iCHP individual MicroTurbine Configuration window will appear allowing you to modify the iCHP turbine settings as they relate to group power demand. Care must be taken that the correct group you wish to modify comes up as shown in the window title bar. The input settings can be seen in Figure 23 and all of these are independent of the electrical power setpoint except the operating mode options explained as follows:

If you select the Bypass or Electrical Priority Operating mode, the electrical power demand settings for the group will be independent of the MicroTurbines' thermal system. If you select the Thermal Priority operating mode, the power setpoint for the group of turbines will be determined by a control algorithm calculated at the group level that will set the power demand of the group to control the water temperature being produced to the user-desired value. For Thermal Priority mode, both temperature feedback measurement and setpoint control must be done at the APS. Also, the same measurement and setpoint must be used for any Grid Connect groups that include iCHP units that are also in the Stand Alone group. Consult the APS Technical Reference (480023) for additional details.

For details of how to set up the rest of the options in this window for iCHP settings, see the next section on configuring a group, as you should only use this access to select the Thermal Priority mode of operation.

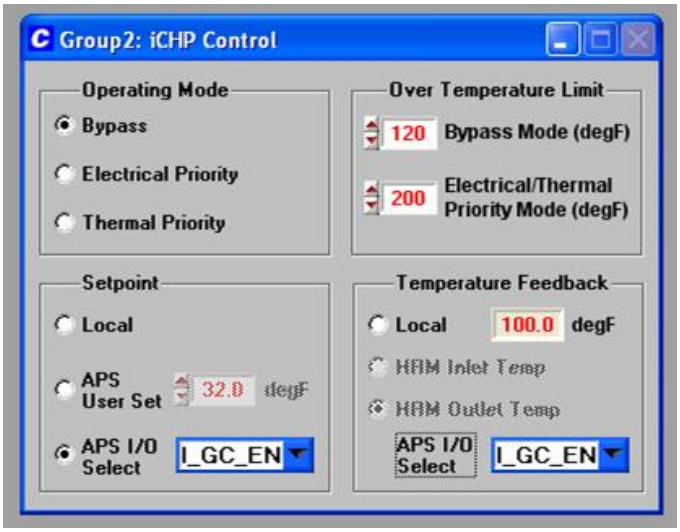


Figure 23. Group"X": iCHP Control Window

Start Dispatch Dispatch Sequence Settings

The Start Dispatch settings control how the MicroTurbines within the group are started once the group has received a start command. There are two options that determine how the MicroTurbines within a group are started, Priority mode and Run Time Balance mode. The "Power Dispatch" Dispatch Sequence Settings described later have an impact on whether the Start Dispatch settings are active or not. Priority mode or Run Time Balance mode will only be active when the "Max Efficiency Power Dispatch" Dispatch mode is selected. **Care should be taken to always select either Priority or Run Time Balance when in the max efficiency mode of operation as it is not possible to turn them both off even if neither item has a check mark next to it in the dispatch sequence.**

When the Priority mode is selected, the MicroTurbines are started based on a pre-defined set of criteria that is outlined in Table 8, by priority order where the lower number represents a higher priority for starting the turbines. This will typically create a repeatable pattern of starting of MicroTurbines within a group.

Table 8. Priority Mode Start Criteria

Priority Level	Description
1	Units that have been manually forced "on" by the user (already running and cannot be turned off).
2	All things being similar, turbine capacity and turbine's current run status, then the units with the lower assigned turbine number are higher rated and started first.

The other available mode for determining which turbines to start within a group is Run Time Balance mode. Using this mode, the turbines are continually cycled by starting a new unit and turning off a running unit to maintain the similar operating hours on the turbines within a group. Setup of this turbine-starting mode can be adjusted using the two input textboxes as shown in Figure 19 and defined below.

- **Start Operating Hours Delta:**
  This setting determines the power level between the running MicroTurbine with the highest operating hours and the non-running MicroTurbine with least operating hours that will cause the high time running unit to be turned off and the low time non-running unit to be turned on. This allows you to adjust the cyclic nature of the group of turbines.
- **Minimum Run Time (Hours):**
  This setting determines the minimum time a MicroTurbine that was recently turned on will run before it is allowed to be available to be turned off. This is irrespective of the Start Operating Hours Delta setting which means that the unit will not be turned off to balance out the operating hours of the group until this time expires. This input will keep units from being rapidly turned on and then off due to other external events.

Power Dispatch Dispatch Sequence Settings

The Power Dispatch configuration settings are the settings that control how the individual MicroTurbines within the group are run to meet the power demand of the group. There are three different modes of operation for Power Dispatch. The first and most basic mode is the load balance mode. In this mode, the power demand for the group is split equally between all the functional turbines and all the turbines are run regardless of the level of the power demand. This mode of operation is good if your load is relatively continuous and near the full capacity of all the turbines in the group. The Stop Delay Time (min) value, as shown in Figure 19, associated with the Load Balance selection box is not currently used and will have no effect on operation.

The next available power dispatch mode is the Max Efficiency mode. This mode tries to run the minimum number of turbines at or near full power to meet the load demand. This automated mode of operation is a good choice if the load varies significantly during operation. For example, if your load is 230kW during the day, with a six-unit group the Max Efficiency operating mode would most likely be running four C65 units. If the load drops to 50kW at night, the Max Efficiency control would most likely turn off three units and only run one unit. Keeping the running units as close to their available output maximizes their running efficiency, which minimizes fuel costs.

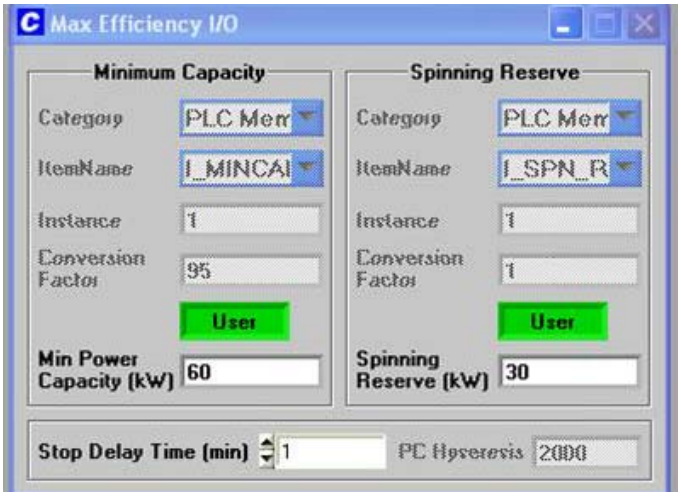


Figure 24. Max Efficiency I/O Window

When you click the Maximum Efficiency power dispatch mode of operation checkbox, the Max Efficiency I/O window will appear as shown in Figure 24, allowing you to set up this mode of operation. There are several settings you can adjust to customize the Maximum Efficiency operating mode. For the Minimum Capacity and Spinning Reserve, you have the option of clicking the User button (as seen in Figure 24) to identify if the setting for this input is through the textbox in this window or from an external source. A description and setting options for each distinct input in the Max Efficiency I/O window can be seen in Table 9.

Table 9. Max Efficiency I/O Window Configuration Input Item Definition

Input Item	Description	Available Settings
Category	Memory Category selection list.	See the Table in Appendix 1.
ItemName	Memory item selection list.	See the options in the tables of Appendix 2 that are associated with each group in Appendix 1 Table.
Instance	Selection of entry level for memory category that have multiple entries.	Dependant on the memory category chosen above. (See Appendix 1 for details.)
Conversion Factor	Multiplier applied to selected memory value.	Positive integer values.
Min Power Capacity (kW)	Amount of Power Capacity (or running turbines) to always leave on regardless of how low the power demand goes. (In Stand Alone mode of operation, this value should not be set to zero or no units may turn on to support the load.)	0 to 65535 kW
Spinning Reserve (kW)	Amount of power capacity desired (running turbine capacity), in addition to the current power demand or load. Should be set to the largest expected step load size for the application.	0 to 65535 kW
Stop Delay Time (min)	Timer that keeps a unit that wants to be turned off due to a decrease in the power demand on until the timer expires. Eliminates cycling of units on/off due to quick transient load decrease.	1 to 65532 minutes
PC Hysteresis	Deadband applied to control algorithm that calculates turbine on/off levels.	2000 watts (not adjustable)

The final power dispatch option is the power setpoint mode. Clicking this option in the Power Dispatch section of the Dispatch Sequence window will enable this mode of operation. For directions on how to open this window to edit the settings of the Interactive Power Setpoint Threshold Configuration window, see Table 3. An example of this window for a particular group is shown in Figure 25.

In this mode of operation, you configure the on and off power demand levels associated with each individual turbine in the group. You can double click and edit the on and off threshold levels to change them for each turbine that is in the group being edited. You can also set the on and off delay levels for each turbine. The On Delay option determines the time the individual MicroTurbine waits to start after the power demand exceeds the On Threshold level. Similarly the Off Delay option determines the time the individual MicroTurbine waits to turn off once the power demand drops below the Off Threshold level. Please keep in mind that any changes that set the On Threshold below the Off Threshold will not be accepted as this would not make logical sense.

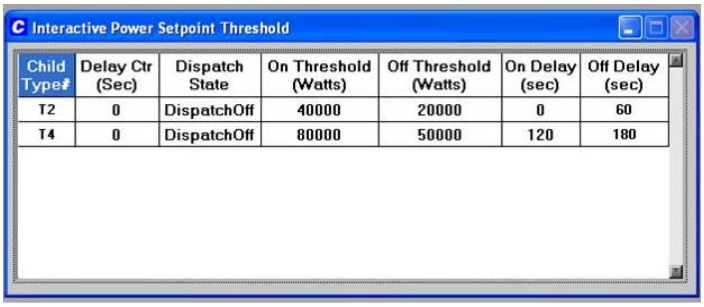


Figure 25. Interactive Power Setpoint Threshold Configuration Window

Configuring a Group's Individual Turbines Setup

Configuring a group's individal turbines setup requires administration access for all settings except the iCHP configuration settings. This configuration operation is primarily done through menu selection from the Advanced Power Server Configure window as shown in Figure 26. First, select the group that you want to edit and then choose the "Edit Group Turbine Config" option from the upper menu on the APS Configure window.

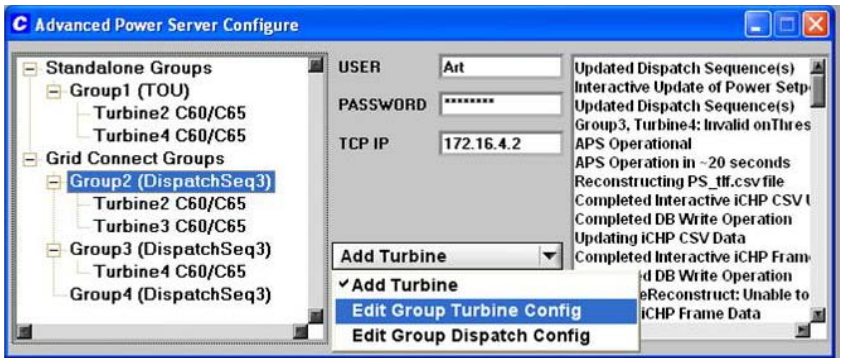


Figure 26. Selecting a Group Turbine Configuration to Edit

Once you have done this, the APS Configure window upper menu will change to display four new choices as shown in Figure 27. Selecting any of these choices will open the associated configuration window for that choice. The final individual turbines configuration window is the Group"X": iCHP Control window which is opened differently, as described in Table 3.

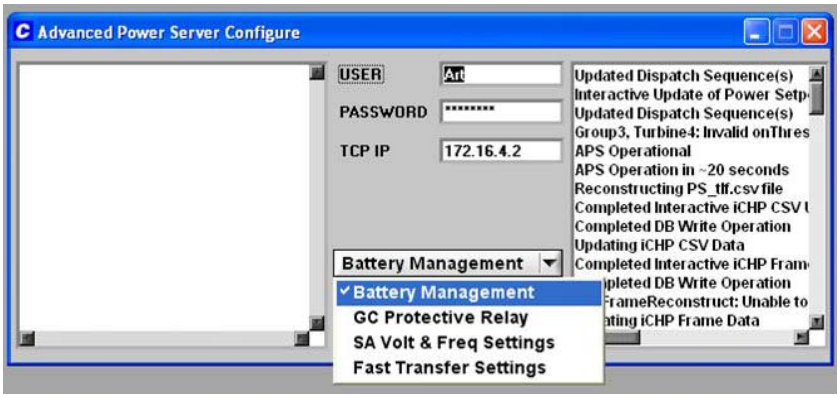


Figure 27. Group Turbine Config Menu Choices

Each of the group's turbine setting categories will be described in detail in their own section below. Once you have opened up the configuration window for the settings you want to edit and make your changes, you will need to save them by clicking the UPDATE button on the APS Configure window (shown in Figure 14) before you leave the Configuration mode or your changes will not be saved. You will still need to upload the changed configuration to the APS controller once all configuration changes are complete.

Battery Management Group Turbine Settings

Battery Management group settings are set through the Group"X": Battery Management window as shown in Figure 28.

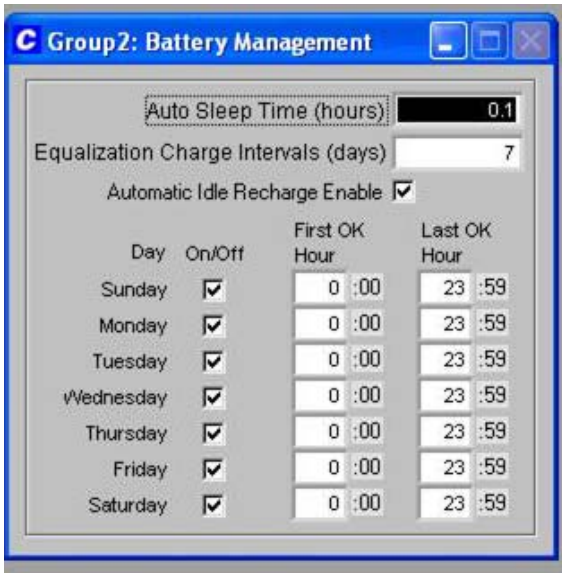


Figure 28. Group"X": Battery Management Configuration Window

This window allows you to configure the battery management settings for the MicroTurbines in the selected group. There are four settings you can adjust, as described below.

- **Auto Sleep Time (hours):**
  Sets the time that an idle Stand Alone MicroTurbine group will operate before turning off its power and shutting down to conserve its battery charge.
- **Equalization Charge Intervals (days):**
  Determines the number of days that the MicroTurbine will operate before initiating equalization charge sequence.
- **Automatic Idle Recharge Enable:**
  This option is an enable/disable input that allows Grid Connect units to perform an equalization charge even if the units are not running (requires unit to turn on the inverter to draw charging power from the utility).
- **Input Table for Allowable Equalization Charge Day and Time:**
  Sets the time and day that a unit is allowed to do an equalization charge (units step load capability is reduced during the charge process).

GC Protective Relay Group Turbine Settings

Grid Connect Protective Relay settings for the individual turbines are set through the Group"X": GC Protective Relay window as shown in Figure 29. This window allows you to set the UL 1741 (or IEEE 1547) utility interconnect settings as required by the local utility for MicroTurbine compliance. When changing these values in any one of the four group windows, all MicroTurbines will automatically be updated to the same values at the same time. Therefore, all MicroTurbines are required to have the same Grid Connect protective relay settings, regardless of which group they are in.

There are six inputs that you can adjust which determine when the associated Grid Connect faults will trip and the units will shutdown and disconnect from the utility. You set the level and time that the associated parameter needs to exceed for the inverter to trip out and shut off. For more details on GC protective relay MicroTurbine settings, refer to the "Protective Relay Functions for Capstone MicroTurbines" Technical Reference (410033).

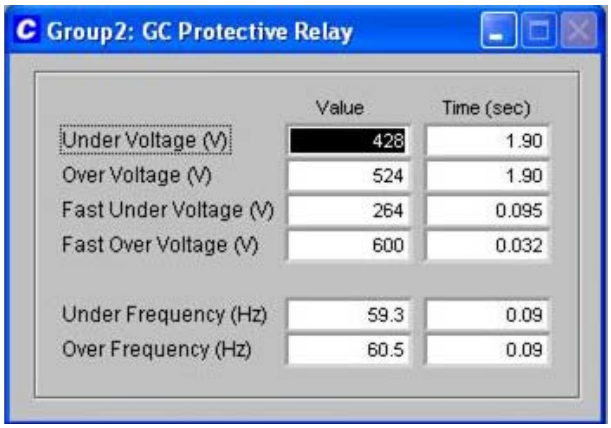


Figure 29. Group"X": GC Protective Relay Window

SA Volt & Freq Group Turbine Settings

Stand Alone Voltage and Frequency settings for the individual turbines are set through the Group"X": SA Voltage & Freq window as shown in Figure 30 below. This window allows you to set both the start and continuous operation voltage and frequency settings for the MicroTurbines. When changing these values in any one of the four group windows, all dual mode MicroTurbines will automatically be updated to the same values at the same time. Therefore, all dual mode MicroTurbines are required to have the same Stand Alone voltage and frequency settings, regardless of which group they are in.

There are ten inputs that you can adjust, four of which determine when the associated Stand Alone faults will be tripped and the unit will shutdown. You set the level and time that (if the associated parameter exceeds) will result in a trip. The other six inputs set the operating voltage and frequency levels for both start and steady state operation of the turbines when running in a Stand Alone configuration. For more details on SA voltage and frequency MicroTurbine settings, refer to the "Stand Alone Operation–Capstone Model C65" Technical Reference (410053).

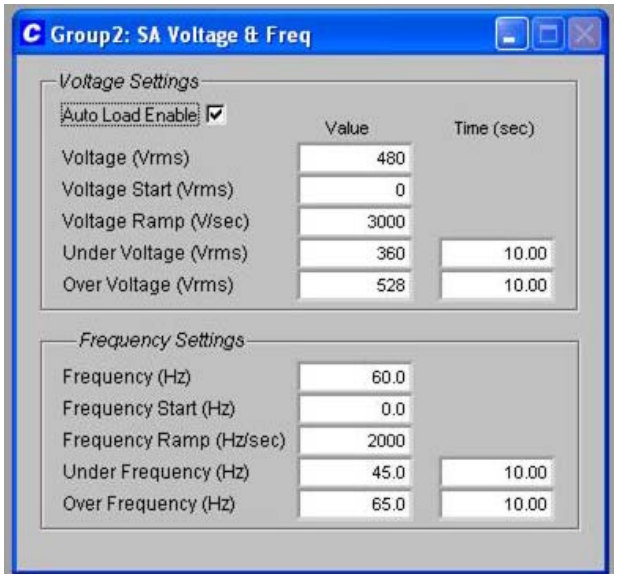


Figure 30. Group"X": SA Voltage & Freq Window

Fast Transfer Group Turbine Settings

Fast transfer settings for the individual turbines within a group are set through the Group"X": Fast Xfer window as shown in Figure 31. This window allows you to set the fast transfer settings for the MicroTurbines within a group that are Dual-Mode units. The APS will also need to be mechanically wired with an associated fast transfer compatible Capstone Dual-Mode Controller for these settings to have any effect. Also, all groups that share Dual-Mode units should have their fast transfer settings set up the same. If this is not done, the slowest fast transfer settings and highest power levels of the four groups that have Dual-Mode units in them will be used. There are five setting that you can adjust as described in Table 10.

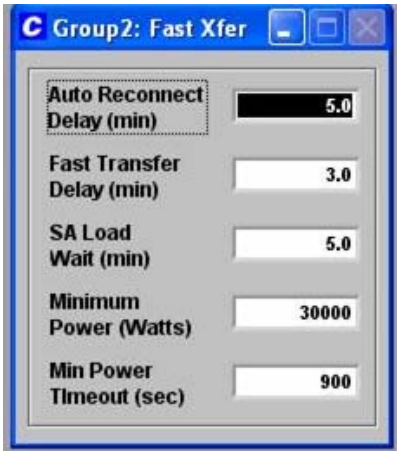


Figure 31. Group"X": Fast Xfer Window

Table 10. Fast Transfer Configuration Input Item Definition

Input Item	Description	Available Settings
Auto Reconnect Delay (min)	Delay that controls the re-connection time of a group of MicroTurbines to the grid (5-minute lower setting is a UL 1741 requirement)	5 to 30 minutes
Fast Transfer Delay (min)	User settable delay that allows the user to extend the time period that the load is without power above the < 10 second level, during a transition.	0 to 30 minutes
SA Load Wait (min)	User settable delay that allows the systems to continue to support the load in Stand Alone operation once the grid has returned. Once this timer expires, the MicroTurbines will start their transition back to Grid Connect mode	0 to 30 minutes
Minimum Power (Watts)	Minimum power required for a Stand Alone system to be capable of carrying on a transitioning into the Stand Alone state from Grid Connect	0 to 4,000,000,000 W
Min Power Timeout (sec)	Timeout period for shutting down the units if there are not enough units to turn on prior to a transition to Stand Alone mode to meet the minimum power setting	0 to 65535 seconds

iCHP Group Turbine Settings

Integrated combined heat and power individual turbines settings within a group are set through the Group"X": iCHP Control window as shown in Figure 32. This window allows you to set the iCHP settings for the iCHP turbines within a group. The settings that you can adjust are described in Table 11.

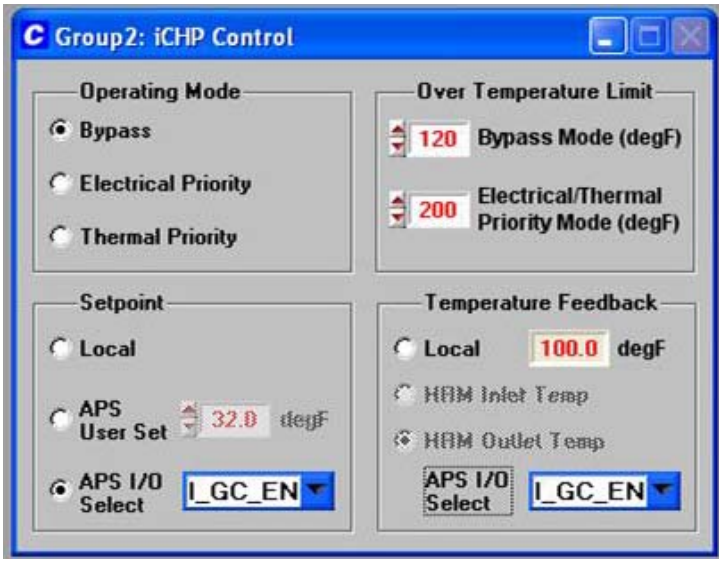


Figure 32. Group"X": iCHP Control Window

Table 11. iCHP Configuration Input Item Definition

Section	Description	Available Settings
Operating Mode	Choice of Mode that the iCHP heat recovery unit operated in.	- Bypass - Electrical Priority - Thermal Priority
Setpoint	Setpoint temperature of the water for the iCHP controller to control to. (Local means the local setting in the individual MicroTurbines memory.)	- Local, set at each turbine. - APS User Set (32 to 221 °F) - APS I/O Select (See Appendix 2, Table of items of PLC Memory)
Over Temperature Limit	The temperature limit where the iCHP unit will declare an over temperature fault for various operating modes as listed.	120 to 221 °F
Temperature Feedback	Location of the temperature reading feedback location that the controller will use. (Local means the local sensor in the individual MicroTurbines.)	- Local → HRM Inlet Temp - Local → HRM Outlet Temp - APS I/O Select (See Appendix 2, Table of items of PLC Memory)

There are three primary operating modes as listed in Table 11. For Bypass mode, the iCHP unit will essentially be turned off and only recover a minimum amount of heat.

In Electrical Priority mode, the iCHP unit in the individual MicroTurbines will vary the exhaust flow to the heat exchanger to try and regulate the water temperature to your chosen setpoint. This regulation of exhaust is done at the individual MicroTurbine level independent of the group's regulation of electrical power. The temperature setpoint to regulate to, when in this mode, can be any of the three possibilities listed in Table 11 above. For temperature feedback location in this mode of operation, any of the three possibilities listed in Table 11 are available. Note that if the APS is selected for either setpoint or temperature feedback measurement, all Grid Connect groups that include iCHP units that are also in the Stand Alone group must use the identical setup.

When operating in the Thermal Priority mode, the local option for the temperature setpoint and feedback is not available because the control is done by the APS at the group level and the control output is group power demand. This power demand is given to the individual MicroTurbines using the power dispatch mode of the group selected. The iCHP unit of the individual MicroTurbines is set to full heat recovery and thermal regulation is accomplished by raising/lower generator electrical output.

For more details on general iCHP operational information and consideration regarding APS control, see the Capstone MicroTurbine User's Manual (400001 or 400017), and APS Technical Reference (480023).

Loading Software and/or a New Operational Configuration onto the APS

Prior to installing software on the APS or updating the configuration, it is important to understand the structure and location of the program and configuration files. Figure 33 below shows the layout of the files in relation to the APS controller and the PC computer that is running APS-CRMS interface software.

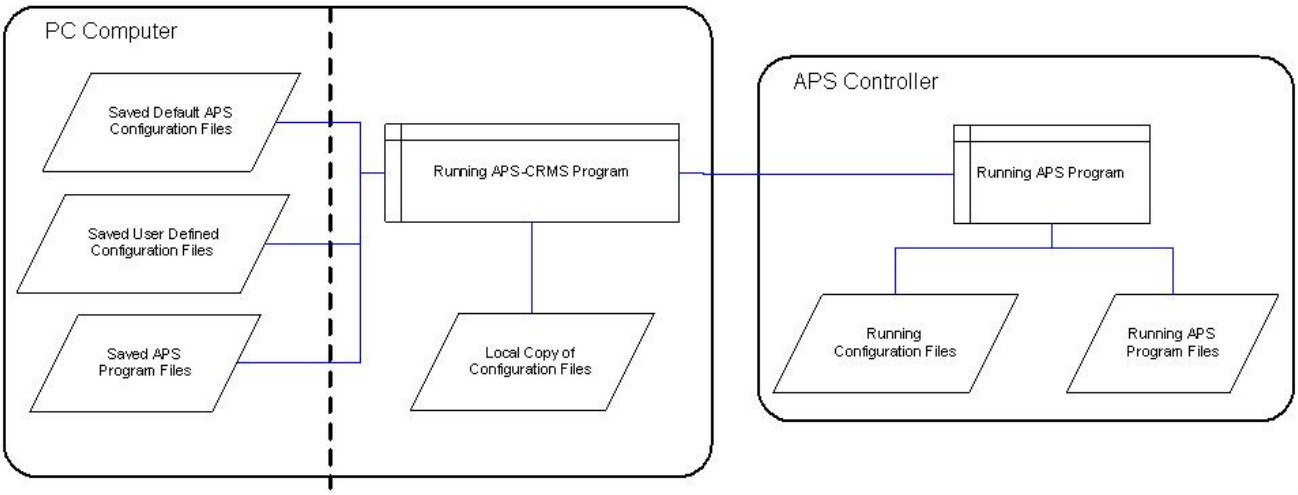


Figure 33. APS Configuration and Program File Locations

When you first connect the APS Controller with the APS-CRMS software, the running configuration files are copied from the APS Controller to the local copy of configuration files on the PC Computer to synchronize the APS-CRMS program view to the APS Controllers configuration. Once this is complete, you have multiple options for changing the APS setup or program. To do this you use the lower drop-down menu that is in the middle of the Advanced Power Server Configuration window as shown in Figure 34 below. Below that is a list of the menu options shown and a detailed description of what each selection will do.

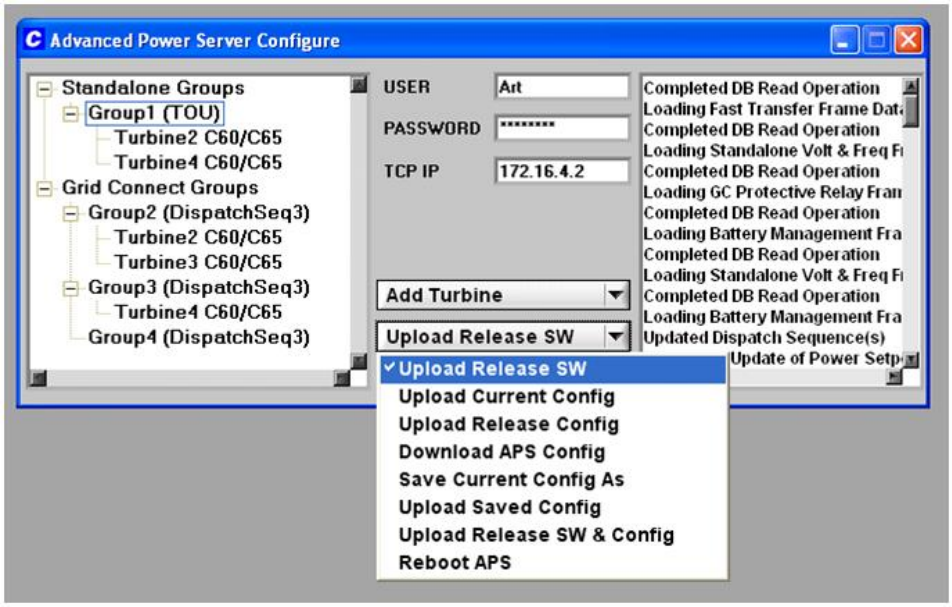


Figure 34. APS Configure Window (Showing Configuration Upload Menu)

Menu Options:

- **Upload Released SW:**
  Copies the correct version of the saved APS program files from the PC Computer to the APS Controller and Reboots the APS Controller to allow it to run the uploaded program.
- **Upload Current Config:**
  Copies the local copy of the configuration files on the PC computer to the running APS configuration files on the APS controller and resets the APS controller to allow it to run the new configuration.
- **Upload Released Config:**
  Copies the saved default copy of the configuration files on the PC Computer to the local copy of the configuration files on the PC Computer and the running APS configuration files on the APS controller and resets the APS Controller to run the default configuration (As this configuration will most likely not match your unique configuration, this option should hardly ever be used).
- **Download APS Config:**
  Copies the running APS configuration files on the APS controller to the local copy of the configuration files on the PC Computer.
- **Save Current Config As:**
  Copies the local copy of the configuration files on the PC computer to the saved user defined configuration files directory with the user-determined name. This allows you to store multiple custom site configurations permanently. When this option is chosen, you are prompted to name the configuration.
- **Upload Saved Config:**
  Copies the chosen saved configuration files on the PC computer to the local copy of the configuration files on the PC Computer and the running APS configuration files on the APS controller then resets the APS Controller to run the saved configuration. When this option is chosen, you will be prompted to choose the name of a saved configuration already created from a pop-up textbox.
- **Upload Released SW & Config:**
  Copies the correct version of the saved APS program files and the saved default copy of the configuration files on the PC computer to the local copy of the configuration files on the PC computer and the running APS configuration files and running APS program files on the APS Controller and resets the APS controller to it to run the new software and default configuration. (As the default configuration will most likely not match your unique configuration, this option should hardly ever be used).
- **Reboot APS:**
  Resets the APS controller to re-launch the APS controller program.

In addition to the commands described above there is one additional command that is used when modifying a systems configuration from the APS-CRMS program window. This command is the "UPDATE" button at the bottom middle of the Advanced Power Server Configure window. When this button is pushed the APS-CRMS program will write what is currently configured in APS-CRMS program to the local copy of the configuration files. This needs to be done any time you modify the configuration in a window before you close that window to access another window or your changes will be lost. Additionally, after you are done editing your configuration, you will still need to save it on the PC computer or upload it to the APS computer using one of the menu options described above or it will be overwritten when you exit the APS-CRMS program.

The APS-CRMS PC software and the APS controller software are a matched set and cannot be intermixed or the APS will not operate correctly. Because of this the APS-CRMS software should always be used to download new APS controller software to avoid a version mismatch.

APS Modbus Master and Slave Register Configuration

The APS controller is equipped to act as a slave device on an RS485 Modbus communications bus to allow it to be monitored and controlled by external building management equipment. This Modbus's register map setup is fully configurable and is explained in detail in one of the following sections.

Additionally the APS controller has an internal RS485 Modbus communications bus to allow it to gather and pass information to/from the internal PLC that is used to communicate with slave Modbus devices. This interface will not need to be configured unless you are using the local balance of plant monitoring and control functionality of the APS controller. If this is the case, the register setup will need to be configured in the APS to match the requirements of your site. Details of how to set up the Master Modbus registers are also detailed below.

APS Controller Register Setup for External Modbus Connection

Creating User Defined Data in I/O_SLAVE Memory Category

The APS can be set up to read data written from the external Modbus Master into memory that is user-defined. To set up the APS controller to allow the Modbus master to write data into new memory in the Slave Modbus Memory category, open up the Slave Write Register configuration window as defined in Table 3. The Slave Write Registers window as shown in Figure 35 will appear allowing you to define any number of input registers.

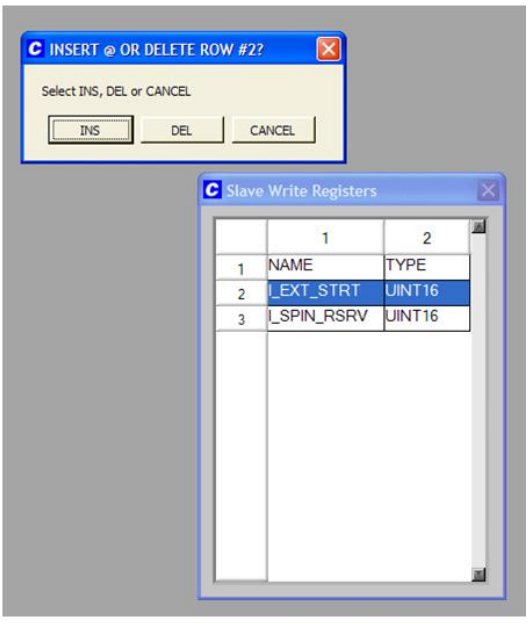


Figure 35. Modbus Slave Write Registers Configuration Window

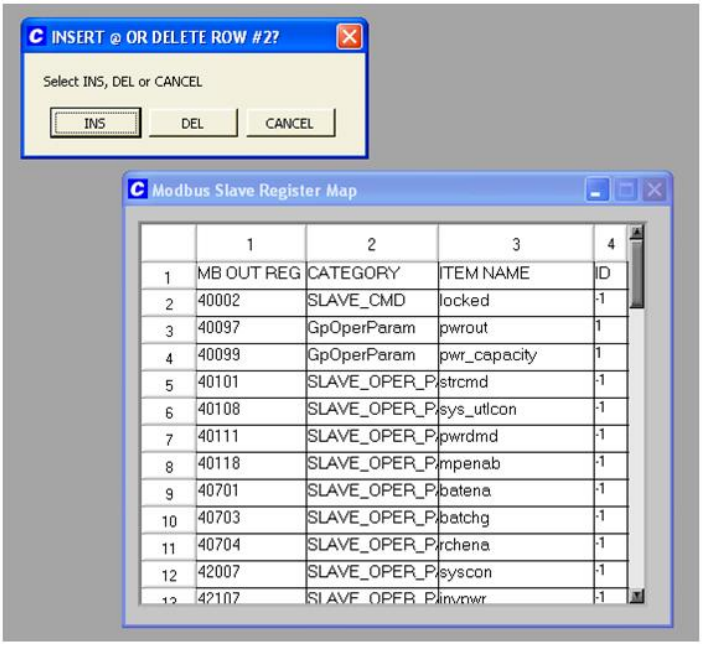
The Slave Write Registers window allows you to create or delete data item entries in the Slave Modbus Memory category (as defined in Appendix 1) of the APS controller by left clicking a line item number. When you do this, a textbox will appear asking you if you want to insert a new line item or delete the one you selected as shown in the top left corner of Figure 35. The default configuration has two registers pre-defined as shown in Figure 35 and in the Slave Modbus Memory Memory Category Item Name Table in Appendix 2. Definition of each column heading of the window is described below.

- **Name:**
  A single word may be used to name the variable in APS memory.
- **Type:**
  The variable must be of one of the following data types: Int16, Uint16, Int32 or Uint32.

Once you have created the names of the new entries in the Slave Modbus Memory category that you need, you can then select to use these values in any of the APS_CRMS windows that allow you to select the memory category and data item to associate to a particular function or setting. To finish configuring these new APS memory data values for use as inputs for the external Modbus Master, you will be required to assign them to APS Modbus Slave registers as described in the next section.

External Slave Modbus Register Setup

You will need to setup the registers in the APS controller to input or output the information that you want to provide to an external Modbus master device. All data in all the data categories is configured for read and write access by the Modbus Master device. For setting up the registers that will be read and/or written to by the Modbus master, open the Modbus Slave Register Map configuration widow as described in Table 3. When you do this you will see the window shown in Figure 36.



	1	2	3	4
1	MB OUT REG	CATEGORY	ITEM NAME	ID
2	40002	SLAVE_CMD	locked	-1
3	40097	GpOperParam	pwrout	1
4	40099	GpOperParam	pwr_capacity	1
5	40101	SLAVE_OPER_P	strcmd	-1
6	40108	SLAVE_OPER_P	sys_utlcon	-1
7	40111	SLAVE_OPER_P	pwrdmd	-1
8	40118	SLAVE_OPER_P	mpenab	-1
9	40701	SLAVE_OPER_P	batena	-1
10	40703	SLAVE_OPER_P	batchg	-1
11	40704	SLAVE_OPER_P	rchena	-1
12	42007	SLAVE_OPER_P	syscon	-1
13	42107	SLAVE_OPER_P	invpwr	-1

Figure 36. Modbus Slave Register Map Window

This window allows you to create register links between APS Controller Modbus registers and memory values in the APS controller by modifying columns 1-4 and also add/delete entries in the table. The default configuration has 63 pre-defined registers, however, you can add to or delete them by left clicking on the line item number. When you do this, a textbox will appear asking you if you want to insert a new line item or delete the one you selected as shown in the top left corner of Figure 36. Refer to Table 12 for descriptions of each column heading.

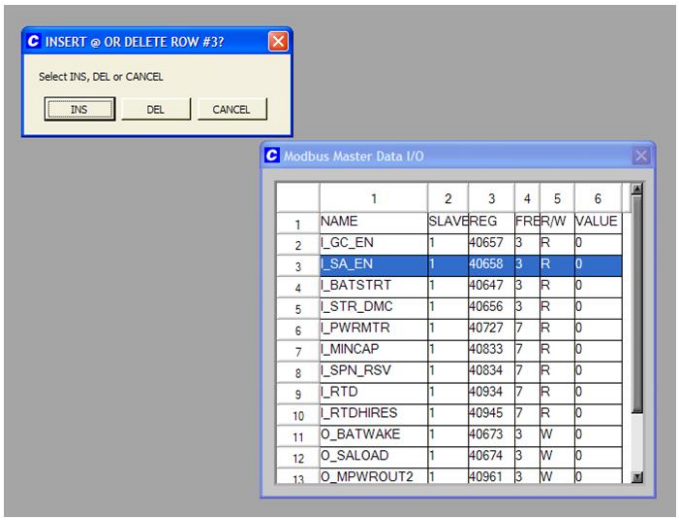
Table 12. Modbus Column Label Definitions

Column Heading	Description	Available Settings
MB OUT REG	Number of the Modbus register associated with the selected memory item.	40001 - 49999
CATEGORY	Memory category selection list.	See the table in Appendix 1.
ITEM NAME	Memory data item selection list.	See the options in the tables of Appendix 2 that are associated with each group in Appendix 1 table.
ID	Selection of entry level for memory category that have multiple entries.	Dependant on memory category chosen above. (See Appendix 1 for details.)

APS Controller Register Setup for Internal PLC Communication

This APS Controller Modbus communication setup window is for the communication between the APS control computer and the PLC internal to the APS product. It is not available for connection to other slave Modbus devices. Because of this, the registers available here and those defined in the PLC code must be a matched set for the APS to operate correctly. Therefore, it is not recommended that these settings be changed in the field unless you have changed or updated the PLC software to incorporate new functionality.

To setup the APS Modbus Internal communication registers, open the Modbus Master Data I/O window as described in Table 3. Once this is done, the window in Figure 37 will appear and allow you to edit the column entries to set up the configuration to match your site's configuration requirements.



	1	2	3	4	5	6
1	NAME	SLAVE	REG	FRE	R/W	VALUE
2	I_GC_EN	1	40657	3	R	0
3	I_SA_EN	1	40658	3	R	0
4	I_BATSTRT	1	40647	3	R	0
5	I_STR_DMC	1	40656	3	R	0
6	I_PWRMTR	1	40727	7	R	0
7	I_MINCAP	1	40833	7	R	0
8	I_SPN_RSV	1	40834	7	R	0
9	I_RTD	1	40934	7	R	0
10	I_RTDHIRES	1	40945	7	R	0
11	O_BATWAKE	1	40673	3	W	0
12	O_SALOAD	1	40674	3	W	0
13	O_MPWROUT2	1	40961	3	W	0

Figure 37. Modbus Master Data I/O Window

This window in Figure 37 allows you to create register links between memory values in the APS controller and PLC registers, by modifying columns 1-5 and also add and delete entries in the window's table and associated APS memory category (PLC Memory). The default configuration has 16 registers pre-defined, but you can add to or delete them by left clicking on the line item number. When you do this, a textbox will appear asking you if you want to insert a new line item or delete the one you selected as shown in top left corner of Figure 37. Table 13 defines what each column is and the available settings that can be used.

Table 13. Modbus Column Label Definitions

Column Heading	Description	Available Settings
Name	Name assigned to memory data items in the I/O_ANA memory category that data read or written from PLC register will be stored. (See Appendix 2, Table of items of I/O_ANA for default values.)	Any single word entry desired by the user.
Slave ID	Selection of entry level for memory category that have multiple entries.	Must be set to "1." (See Appendix 1 for details.)
Reg	PLC registers address that is being accessed.	40001 to 49999
Freq	Sets the cycle count of the data update to and from the PLC. Setting is the number of cycles per data update where 1 would be the fastest. The cycle time is 500 msec.	1 to 100
R/W	Defines if the APS is reading or writing to the PLC. R or Read is to be used for input data points on the PLC, whereas W or Write is for output data points on the PLC.	R or W
Value	Data value currently in memory and PLC register.	Integer value

Configuring the APS Communication Settings

APS Modbus Communication Setup

To setup the APS external Modbus interface that will communicate to an external Modbus Master, first open the Modbus Slave Communication Configure window as described in Table 3. Once this done, the window shown in Figure 38 will appear and allow you to set the communication settings. There are five settings that you can configure. Each one is described in the list below.

- **Com Port:**
  This is the physical communications port being use on the Internal APS Controller and needs to always be set to "2".
- **Baud Rate:**
  This is the baud rate of the communication and can be set between 1200 and 57600 bits/second. ***Current hardware requires this value to be 19200 or more.***
- **Parity:**
  This is the parity of the communication and can be set to none, even, or odd.
- **Protocol:**
  This is the software communication setup for this port and needs to be set to either RTU or ASCII. This must match the settings in the Master device or the communication will not function correctly.
- **Modbus Address:**
  This is the slave address that you want the APS controller to use. This can be set between 1 and 247.

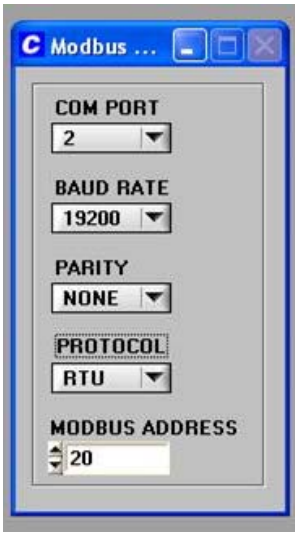


Figure 38. Modbus Slave Communications Window

APS Ethernet LAN Communication Setup

To configure the LAN communication settings of the APS Controller, you need open the MicroTurbine Communication window as described in Table 3. When you do, the window shown in Figure 39 will appear allowing you to edit the APS Ethernet LAN Communication settings. ***None of the available settings should be changed or your APS will no longer function correctly!*** These settings are being shown in Figure 39 so that if they are accidentally modified they can be put back to the correct settings.

The only exception is the "MAX NET CONNECTION" selection that will allow you to set the number of computers running APS-CRMS software that are allowed to connect to the APS at the same time. This connection will be regulated on a first come first served basis. ***Care must be taken to only allow one computer at a time running APS-CRMS software to change configuration settings or the APS software will be corrupted and no longer function correctly.***

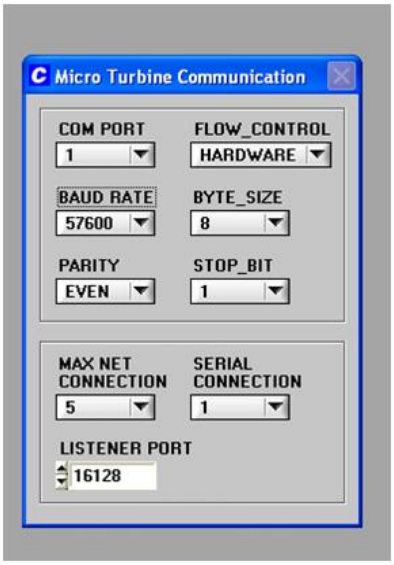


Figure 39. MicroTurbine Communication Window

PRODUCT MAINTENANCE

The APS controller is primarily a device of only low power electronics and as such has very little maintenance requirements. The required maintenance is described in the sections below. For performing the actual maintenance, contact your local service representative or Capstone directly at the contact numbers in the Capstone Contact Information section at the end of this document, if you are not sure who your service representative is.

UPS Battery Maintenance

The APS product includes a small UPS to allow it to operate during a transition from Grid Connect to Stand Alone operation. This device is self-regulating but needs to have the batteries checked every two years. If the batteries have been charged for a minimum of eight hours and the UPS fails the self test, the unit should be replaced as there are no serviceable items in the UPS.

PLC Battery Maintenance

The PLC computer has a small battery to back up its memory. This battery must be replaced every four years.

PRODUCT SPECIFICATIONS

CE Listings

- 73/23/EEC with amendment of 93/68/EEC, *Low Voltage Directive*
- 89/336/EEC with amendments up to 2004/108/EC, Electromagnetic Compatibility (EMC) Directive

APS-CRMS Software Computer Requirements

- Operating System: Windows XP, XP PRO or Windows 2000
- Processor: Pentium or equivalent processor of 1 GHz or greater speed
- Memory: 512 MByte or greater

Capstone MicroTurbine Requirements

- Only C60 and C65 Series MicroTurbines can be connected to the APS.
- MicroTurbines must have system software version v4.50 Rev J or later.

Additional Specifications

Refer to APS Technical Reference (480023) as required.

REFERENCE DOCUMENTS

Table 14 lists applicable Capstone reference documents.

Table 14. Reference Documents

Document No.	Document Title
410033	MicroTurbine Protective Relay Functions Technical Reference
410053	Stand Alone Operation Technical Reference
480023	Advanced Power Server Technical Reference
480024	Advanced Power Server Installation Specification
480027	Advanced Power Server Commissioning Procedure & Checklist

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APPENDIXES

Appendix 1–Table of Memory Data Categories

Category Identifier	Data Description
Turbine Settings	Memory data category that is the command data sent down to each group for use on its turbines. (One category list exists for each turbine group and can be accessed using ID set to the group number.)
Turbine Status Data	Memory data category that is the command data sent down to each MicroTurbine. (One category list exists for each MicroTurbine and can be accessed using ID set to the MicroTurbine number.)
Turbine Commands	Memory data category that is status information received from each MicroTurbine in response to commands sent by APS. (One category list exists for each MicroTurbine and can be accessed using ID set to the MicroTurbine number.)
Turbine Command Response	Second memory data category that is status information from each MicroTurbine. (One category list exists for each MicroTurbine and can be accessed using ID set to the MicroTurbine number.)
PLC Memory	Memory data category that is read from or written into the PLC. (Only one category list exists for this category, so the ID should be always be set to "1".)
Slave Modbus Memory	Memory data category that is written into APS by an external Modbus Master. (Only one category list exists for this category, so the ID should be always be set to "1".)
APS Settings	Memory data category that is APS specific settings (Only one category list exists for this category, so the ID should always be set to "1".)
Group Commands	Memory data category that is the set of commands determined by APS for each APS Group. (One category list exists for each APS Group and can be accessed using ID set to APS group number.)
Group Command Response	Memory data category that is the set of status information for each APS Group. (One category list exists for each APS Group and can be accessed using ID set to APS group number.)

Appendix 2–Tables of Memory Category Item Names

TURBINE SETTINGS Memory Category Item Name Table

Data Identifier	Data Type	Data Units	Data Scale	Data Description
FRAME_ID	INT16	number	1	Structure ID (corresponds to turbine number)
version	UINT16	number	1	Frame version
length	UINT16	number	1	Frame structure length
next_struct	UINT16	number	1	Address of next PM structure
baud_rate_user	UINT32	bps	1	User port baud rate
baud_rate_maint	UINT32	bps	1	Maintenance port baud rate
baud_rate_optn	UINT32	bps	1	Option port baud rate
ethernet_ip_addr	UINT8 (4)	number	1	Ethernet IP address
ethernet_hw_addr	UINT8 (6)	number	1	Ethernet hardware address
user_protected_psswrd	UINT8 (10)	string	1	User level password
maint_admin_adj_psswrd	UINT8 (10)	string	1	Maintenance level password
user_dial_back_num	UINT8 (32)	string	1	Up to 31-character NULL terminated string using standard modem protocol (P – pulse dialing, comma ',' for delay, etc.)
maint_dial_back_num	UINT8 (32)	string	1	Up to 31-character NULL terminated string using standard modem protocol (P – pulse dialing, comma ',' for delay, etc.)
download_dial_back_num	UINT8 (32)	string	1	Up to 31-character NULL terminated string using standard modem protocol (P – pulse dialing, comma ',' for delay, etc.)
utility_connect_mode	UINT16	number	1	User defined Utility connection mode
ac_voltage	UINT16	volt	1	Output voltage
ac_frequency	UINT16	hertz	1	Output frequency
auto_enable	UINT16	number	1	Auto load enable flag
power_demand	UINT16	number	1	Power demand
transient_pwr_demand	UINT16	number	1	Transient power demand
altitude	UINT16	number	1	Site configuration data

Data Identifier	Data Type	Data Units	Data Scale	Data Description
latitude	UINT16	number	1	Site configuration data
longitude	UINT16	number	1	Site configuration data
timezone	UINT16	number	1	Site configuration data
estop_count	UINT32	number	1	Number of emergency stops
auto_start	UINT16	number	1	Autorestart flag
usr_protmd_dsplypswrd	UINT8 (10)	string	1	User level password for display access
maint_admin_dsplypswrd	UINT8 (10)	string	1	Maintenance level password for display access
amb_press	UINT16	psi	0.00195	Ambient pressure
amb_press_date	UINT32	number	1	Date when ambient pressure was recorded
amb_press_time	UINT32	number	1	Time when ambient pressure was recorded
fuel_index2	UINT16	number	1	Fuel ID to determine valve command
fuel_index1	UINT16	number	1	Fuel ID 2 to determine valve command
under_volt_value	UINT16	volt	1	Under voltage value
under_volt_time	UINT16	second	0.01	Time limit for under voltage fault declaration
over_volt_value	UINT16	volt	1	Over voltage value
over_volt_time	UINT16	second	0.01	Time limit for over voltage fault declaration
fast_over_volt	UINT16	volt	1	Fast over voltage value
fast_under_volt	UINT16	volt	1	Fast under voltage value
under_freq_value	UINT16	hertz	0.1	Under frequency value
under_freq_time	UINT16	second	0.01	Under frequency fault time
over_freq_value	UINT16	hertz	0.1	Over frequency value
over_freq_time	UINT16	second	0.01	Over frequency fault time
med_btu_mode	UINT16	number	1	Medium BTU flag
display_format	UINT16	number	1	Display format (English or Metric)
start_voltage	UINT16	number	1	Stand Alone start voltage
start_voltage_ramp	UINT16	volt/second	1	Stand Alone voltage ramp
start_freq	UINT16	hertz	1	Stand Alone start frequency

Data Identifier	Data Type	Data Units	Data Scale	Data Description
start_freq_ramp	UINT16	hertz/second	1	Stand Alone frequency ramp
sa_over_volt	UINT16	volt	1	Stand Alone over voltage
sa_under_volt	UINT16	volt	1	Stand Alone under voltage
sa_over_volt_time	UINT16	second	0.01	Stand Alone undervoltage fault time limit
sa_under_volt_time	UINT16	second	0.01	Stand Alone overvoltage fault time limit
sa_auto_sleep	UINT16	minute	1	Stand Alone automatic sleep time
sa_day_permission	UINT16	number	1	Stand Alone day setting for equalization charge
sa_hr_permission1	UINT8 (4)	number	1	Stand Alone hour setting for equalization charge
sa_hr_permission2	UINT8 (4)	number	1	Stand Alone hour setting for equalization charge
sa_hr_permission3	UINT8 (4)	number	1	Stand Alone hour setting for equalization charge
sa_hr_permission4	UINT8 (4)	number	1	Stand Alone hour setting for equalization charge
sa_hr_permission5	UINT8 (4)	number	1	Stand Alone hour setting for equalization charge
sa_hr_permission6	UINT8 (4)	number	1	Stand Alone hour setting for equalization charge
sa_hr_permission7	UINT8 (4)	number	1	Stand Alone hour setting for equalization charge
sa_under_freq	UINT16	hertz	1	Stand Alone under frequency
sa_under_freq_time	UINT16	second	0.01	Stand Alone under frequency time limit
sa_over_freq	UINT16	hertz	1	Stand Alone over frequency
sa_over_freq_time	UINT16	second	0.01	Stand Alone over frequency time limit
gc_autorestart_delay	UINT16	minute	0.1	Grid Connect auto restart delay
sa_autorestart_delay	UINT16	minute	0.1	Stand Alone auto restart delay
outrelay_state	UINT16	number	1	Output relay state
start_input	UINT16	number	1	Start mode
master_pwrdmd	UINT32	watt	1	Master power demand
multipac_enable	UINT16	number	1	MultiPac enable flag
multipac_turbno	UINT16	number	1	Turbine number
user_start	UINT16	number	1	User defined start mode

Data Identifier	Data Type	Data Units	Data Scale	Data Description
eucb_fncs	UINT16 (6)	number	1	UCB function codes
flt_input1_ena	UINT16	number	1	Fault input 1 enable flag
flt_input1_ssl	UINT16	number	1	Fault input 1 severity level
flt_input1_deb	UINT16	second	0.1	Fault input 1 debounce
flt_input2_ena	UINT16	number	1	Fault input 2 enable flag
flt_input2_ssl	UINT16	number	1	Fault input 2 severity level
flt_input2_deb	UINT16	second	0.1	Fault input 2 debounce
flt_input3_ena	UINT16	number	1	Fault input 3 enable flag
flt_input3_ssl	UINT16	number	1	Fault input 3 severity level
flt_input3_deb	UINT16	second	0.1	Fault input 3 debounce
flt_input4_ena	UINT16	number	1	Fault input 4 enable flag
flt_input4_ssl	UINT16	number	1	Fault input 4 severity level
flt_input4_deb	UINT16	second	0.1	Fault input 4 debounce
minpwr	UINT32	watt	1	Minimum power for stand Alone load
mpwrto	UINT16	second	1	Time for minimum power check
fast_under_volt_time	UINT16	second	0.01	Fast under voltage time limit
fast_over_volt_time	UINT16	second	0.01	Fast over voltage time limit
eal_mode	UINT16	number	1	External auxiliary load mode
med_btu_def	UINT16	number	1	Medium BTU flag
eng_mode	UINT16	number	1	Engine operation mode
mdm_pwr_sts	UINT16	number	1	Modem power status
lfc_boostpump	UINT16	number	1	Boost pump installed flag (liquid fuel)
lfc_initiate_prime	UINT16	number	1	Prime command (liquid fuel)
lfc_fueldev_primed	UINT16	number	1	Prime status (liquid fuel)
lfc_num_failed_linefill	UINT16	number	1	Number of failed line fills (liquid fuel)
lfc_mid_float_delay	UINT16	second	1	Drain purge delay to low sensor (liquid fuel)
lfc_no_float_delay	UINT16	second	1	Drain purge delay to below low sensor (liquid fuel)

Data Identifier	Data Type	Data Units	Data Scale	Data Description
lfc_prime_mid_fill_delay	UINT16	number	1	Fill delay to low sensor during priming (liquid fuel)
fuel_index3	UINT16	number	1	Fuel index 3
lfc_control_method	UINT16	number	1	Control mode (liquid fuel)
eng_strt_purge_time	UINT16	second	0.02	Time for fuel purge before starting engine
ign_on_seconds	UINT32	second	1	Igniter ON time
lfc_injsw_1to3plt	UINT16	number	1	Injector switch criteria from 1 to 3 pilot(liquid fuel)
lfc_start_wenergy	UINT16	Btu/s	0.01	Start fuel command (liquid fuel)
lfc_injsw_hysteresis	UINT16	number	1	Hysteresis criteria to avoid erroneous injector switching(liquid fuel)
rtc_daylight_savings_time	UINT16	number	1	Daylight savings time flag
inj1_on_time	UINT32	second	1	Injector 1 usage time
inj2_on_time	UINT32	second	1	Injector 2 usage time
inj3_on_time	UINT32	second	1	Injector 3 usage time
inj4_on_time	UINT32	second	1	Injector 4 usage time
inj5_on_time	UINT32	second	1	Injector 5 usage time
inj6_on_time	UINT32	second	1	Injector 6 usage time
prmx_on_time	UINT32	second	1	Premix injector usage time
unit_total_kwh	UINT32	kWH	1	Kilowatt hour produced
unit_ws	UINT32	watt	1	Watts produced in the last hour
num_2_to_3_sw	UINT32	number	1	Number of switches between 2 to 3 injectors
num_6_to_5_sw	UINT32	number	1	Number of switches between 6 to 5 injectors
num_1_to_3_sw	UINT32	number	1	Number of switches between 1 to 3 injectors
num_3_to_1_sw	UINT32	number	1	Number of switches between 3 to 1 injectors
one_pilot_sec	UINT32	second	1	Pilot 1 usage time
two_pilot_sec	UINT32	second	1	Pilot 2 usage time
three_pilot_sec	UINT32	second	1	Pilot 3 usage time
four_pilot_sec	UINT32	second	1	Pilot 4 usage time

Data Identifier	Data Type	Data Units	Data Scale	Data Description
five_pilot_sec	UINT32	second	1	Pilot 5 usage time
six_pilot_sec	UINT32	second	1	Pilot 6 usage time
prmx_pilot_sec	UINT32	second	1	Premix pilot usage time
days_per_eqcharge	UINT16	day	1	Interval between equalization charge
auto_idle_recharge	UINT16	number	1	Flag for automatic recharge in Idle state
DC_load	UINT16	number	1	DC load allowed flag
soc_overload_batt_low	UINT16	number	1	Minimum state of charge allowed for load condition
heatsink_temp_max	UINT16	degrees Celsius	1	Maximum heatsink temperature
new_eucb_fncs	UINT16	number	1	New UCB function flag
lfc_systyp	UINT16	number	1	System flag to determine operation(liquid fuel)
lfc_xducer_scale	UINT16	number	0.1	Pressure transducer scale (liquid fuel)
lfc_op_pr	UINT16	psi	0.1	Pressure limit for Open fault (liquid fuel)
lfc_sh_pr	UINT16	psi	0.1	Pressure limit for Short fault (liquid fuel)
lfc_clg_dly	UINT16	millisecond	1	Delay 1 for clog check (liquid fuel)
lfc_clg_wait	UINT16	millisecond	1	Delay 2 for clog check (liquid fuel)
lfc_clg_pr	UINT16	psi	0.1	Pressure for clog check (liquid fuel)
lfc_fill_pr	UINT16	psi	0.1	Pressure for line fill check (liquid fuel)
lfc_hi_pr	UINT16	psi	0.1	Pressure limit for high pressure fault (liquid fuel)
chpmod	UINT16	number	1	CHP mode of operation
Analog_input1_fnc	UINT16	number	1	Analog Input 1 Function
Analog_input1_mode	UINT16	number	1	Sense mode for Input 1
Analog_input2_fnc	UINT16	number	1	Analog Input 2 Function
Analog_input2_mode	UINT16	number	1	Sense mode for Input 2
Analog_input3_fnc	UINT16	number	1	Analog Input 3 Function
Analog_input3_mode	UINT16	number	1	Sense mode for Input 3
Analog_input4_fnc	UINT16	number	1	Analog Input 4 Function

Data Identifier	Data Type	Data Units	Data Scale	Data Description
Analog_input4_mode	UINT16	number	1	Sense mode for Input 4
Analog_input5_fnc	UINT16	number	1	Analog Input 5 Function
Analog_input5_mode	UINT16	number	1	Sense mode for Input 5
Analog_input6_fnc	UINT16	number	1	Analog Input 6 Function
Analog_input6_mode	UINT16	number	1	Sense mode for Input 6
Analog_input7_fnc	UINT16	number	1	Analog Input 7 Function
Analog_input7_mode	UINT16	number	1	Sense mode for Input 7
Analog_input8_fnc	UINT16	number	1	Analog Input 8 Function
Analog_input8_mode	UINT16	number	1	Sense mode for Input 8
master_chpset	UINT16	degrees Fahrenheit	1	CHP temperature setpoint (form Master unit)
master_chpflw	UINT16	number	1	CHP flow value (from Master unit)
chptru	UINT16	number	1	CHP module installed flag
pwrdmd_ana_low	UINT32	number	1	Analog power demand minimum value
pwrdmd_ana_high	UINT32	number	1	Analog power demand maximum value
extrn_fdbk_low	UINT16	number	1	Analog external temperature sensor minimum value
extrn_fdbk_high	UINT16	number	1	Analog external temperature sensor maximum value
chp_pv_rtd	UINT16	number	1	Code to determine temperature sensor for CHP mode
mp_chpset_src	UINT16	number	1	CHP temperature setpoint source
mp_chpfbk_src	UINT16	number	1	CHP temperature feedback source
chp_act_overtemp	UINT16	degrees Fahrenheit	1	CHP over temperature value for active state
chp_nhr_overtemp	UINT16	degrees Fahrenheit	1	CHP over temperature value for no-heat-recovery state
tet_wf_kp	UINT32	number	1	Engine controls Proportional gain
tet_wf_ki	UINT32	number	1	Engine controls Integral gain
diginp_act_state	UINT16	number	1	Digital Input active state
fltinput_state	UINT16	number	1	Fault input active state
gc_ena_mode	UINT16	number	1	Grid enable mode upon grid detection

Data Identifier	Data Type	Data Units	Data Scale	Data Description
grid_reconn_delay	UINT16	minute	0.1	Minimum delay before connecting to the grid during fast transfer
FuelValveSetting	UINT16	number	0.01	Fuel valve setting for different fuel types
SysType_Word1	UINT16	number	1	System identifier (high)
SysType_Word2	UINT16	number	1	System Identifier (low)
chp_overtemp_max	UINT16	degrees Fahrenheit	1	CHP max over temperature default value
chp_overtemp_max_lo	UINT16	degrees Fahrenheit	1	CHP max over temperature – lower limit
chp_overtemp_max_hi	UINT16	degrees Fahrenheit	1	CHP max over temperature – upper limit
chp_overtemp_lo	UINT16	degrees Fahrenheit	1	CHP over temperature fault – lower limit
chp_overtemp_hi	UINT16	degrees Fahrenheit	1	CHP over temperature fault – upper limit
chp_set_lo	UINT16	degrees Fahrenheit	1	CHP setpoint – lower limit
chp_set_hi	UINT16	degrees Fahrenheit	1	CHP setpoint – upper limit
fuel_leak_flt	UINT16	number	1	Flag for fuel leak check detection
fast_trans_delay	UINT16	minute	0.1	Minimum delay for fast transfer transition
sa_load_wait	UINT16	minute	0.1	Minimum wait time in stand Alone load state after the grid is back
vent_mk_set	UINT16	number	1	Flag for fuel vent mechanism hardware

Turbine Status Memory Category Item Name Table

Data Identifier	Data Type	Data Units	Data Scale	Data Description
TURBNO	INT16	number	1	Structure ID (corresponds to Turbine number)
time_stamp	INT32	millisecond	1	Packet transmission time
pwrdmd	INT32	watt	1	Power Demand
Strcmd	INT32	number	1	Start Command
Rchena	INT32	number	1	Recharge enable flag
cd_utlcon	INT32	number	1	User defined Utility Connection
sys_utlcon	INT32	number	1	System Utility Connection Status
contr_cmd	INT16	number	1	Contactor command
cd_init_ok	INT16	number	1	Flag indicating new Frame Data Structure
cd_init_cntr	INT16	number	1	Control data initialization counter
gc_enable	INT16	number	1	Grid Connect enable flag
Batena	INT32	number	1	Battery enable flag
Batchg	INT32	number	1	Battery charge request flag
inv_master	UINT8	number	1	Inverter master
oper_state	INT16	number	1	System operating state
Locked	INT16	number	1	Child status with respect to APS
tx_comm_to	INT16	number	1	Maximum number of cycles between consecutive MultiPac communications
reset_cntr	INT16	number	1	Flag to clear the autorestart counter
eal_cmd	INT16	number	1	C30 specific : flag to enable external auxiliary loads
chpmod	UINT8	number	1	Mode of CHP operation (0: Bypass, 1: Electrical, 2: Thermal)
Chpset_val	INT16	degrees Fahrenheit	1	CHP Temperature Setpoint
Chpset_src	UINT8	number	1	CHP Temperature Setpoint Source
Chpfbk_val	INT16	degrees Fahrenheit	1	CHP Temperature Feedback
Chpfbk_src	UINT8	number	1	CHP Temperature Feedback Source

Turbine Commands Memory Category Item Name Table

Data Identifier	Data Type	Data Units	Data Scale	Data Description
TURBNO	INT16	number	1	Structure ID (corresponds to Turbine Number)
time_stamp	INT32	number	1	Packet transmission time
mpenab	INT32	number	1	MultiPac status
pwrdmd	INT32	watt	1	Power Demand
strcmd	INT32	number	1	Start Command
rchena	INT32	number	1	Recharge enable flag
cd_utlcon	INT32	number	1	User Defined Utility Connection
sys_utlcon	INT32	number	1	System utility connection
contr_status	INT16	number	1	Contactor Status
cd_init_ok	INT16	number	1	Flag indicating new Frame Structure
batena	INT32	number	1	Battery enable flag
batchg	INT32	number	1	Battery charge flag
oper_state	INT16	number	1	Operating State
gc_wait_done	INT16	number	1	Grid Connect wait completion flag
syscon	INT32	number	1	System Status
ok_to_load	INT16	number	1	Ok to load flag
turbno	INT16	number	1	Turbine number
max_pwrdmd	INT32	—	1	Maximum power demand of the turbine
ok_to_run	INT16	number	1	Ok to run flag
autorestart_cnt	INT16	number	1	Auto restart counter
rx_comm_to	INT32	number	1	Max number of cycles available between consecutive transmission packets
engspd	INT32	rpm	2	Engine Speed
invpwr	INT32	watt	1	Inverter Power
genpwr	INT32	watt	1	Generator Power
va	UINT16	volt	0.0625	Voltage Phase A
vb	UINT16	volt	0.0625	Voltage Phase B
vc	UINT16	volt	0.0625	Voltage Phase C
vn	UINT16	volt	0.0625	Voltage Neutral

Data Identifier	Data Type	Data Units	Data Scale	Data Description
ia	INT16	amp	0.0625	Current Phase A
ib	INT16	amp	0.0625	Current Phase B
ic	INT16	amp	0.0625	Current Phase C
in	INT16	amp	0.0625	Current Neutral
total_curr	INT32	amp	0.0625	Total current
pwr_capacity	INT32	watt	1	Actual Power capacity of the turbine under current conditions
ok_to_eal	INT16	number	1	C30 only : ok to enable external auxiliary load
inv_master	UINT8	number	1	Turbine number of the inverter master

Turbine Command Response Memory Category Item Name Table

Data Identifier	Data Type	Data Units	Data Scale	Data Description
TURBNO	INT16	number	1	Structure ID (corresponds to turbine number)
DAQ_UNIT_FREQ	INT32	hertz	0.0625	Frequency
DAQ_UNIT_TET	INT32	degrees Fahrenheit	0.125	Engine Exhaust Temperature
DAQ_UNIT_RPM	INT32	rpm	2	Engine Speed
DAQ_UNIT_FULPCNT	INT32	percent (%)	0.1	Fuel command
DAQ_UNIT_BATV	INT32	volt	0.0488	Battery Voltage
DAQ_UNIT_BATI	INT32	amp	0.0488	Battery Current
DAQ_UNIT_BATSOC	INT32	percent (%)	0.1	Battery State of Charge
DAQ_UNIT_LEQDATE	UINT32	time	Time format	Date of last equalization charge
DAQ_UNIT_BATSTATE	INT32	number	1	Battery State
DAQ_UNIT_BATTMP	INT32	degrees Celsius	1	Battery Temperature
DAQ_UNIT_BATKW	INT32	kW	1.2207	Battery Power
DAQ_UNIT_INTMP	INT32	degrees Fahrenheit	0.125	Ambient temperature
DAQ_UNIT_PAMB	INT32	psi	0.0625	Ambient Pressure
DAQ_UNIT_PSVOLT	INT32	volt	0.0625	Voltage of Power Supply
DAQ_UNIT_INVTMP	INT32	degrees Celsius	1	Inverter heatsink temperature
DAQ_UNIT_GENTMP	INT32	degrees Celsius	1	Generator heatsink temperature
DAQ_UNIT_WARRHR	INT32	time	Time format	Operating Hours (formatted as low 4 byte as sends next byte as minutes and the high bytes as hours)
DAQ_UNIT_WARRST	INT32	number	1	Number of Starts
DAQ_UNIT_FLTSSL_ADMIN	INT32	number	1	Severity level of highest admin level fault
DAQ_UNIT_FLTCODE_ADMIN	INT32	number	1	Fault code of highest admin level fault
DAQ_UNIT_FLTSSL_BASE	INT32	number	1	Severity level of highest base level fault
DAQ_UNIT_FLTCODE_BASE	INT32	number	1	Fault code of highest base level fault

PLC Memory Memory Category Item Name Table (Default; user can modify data entries)

Data Identifier	Data Type	Data Units	Data Scale	Data Description
KEY_ID	INT16	number	1	Structure ID
I_GC_EN	UINT16	number	1	Grid Connect interconnect flag
I_SA_EN	UINT16	number	1	Stand Alone interconnect flag
I_BATSTRT	UINT16	number	1	Battery start command
I_STR_DMC	UINT16	number	1	Dual-Mode controller start command
I_PWRMTR	UINT16	number	1	Power meter input (scale is determined based on transducer type)
I_MINCAP	UINT16	number	1	Minimum capacity input (scale is determined based on transducer type)
I_SPN_RSV	UINT16	number	1	Spinning reserve input (scale is determined based on transducer type)
I_RTD	UINT16	degrees Fahrenheit	1	Temperature sensor input
I_RTDHIRES	UINT16	degrees Fahrenheit	0.1	Temperature sensor input (hi-res)
O_BATWAKE	UINT16	number	1	Battery wakeup output signal
O_SALOAD	UINT16	number	1	Stand Alone load output signal
O_MPWROUT2	UNIT16	number	1	MultiPac power output (high word)
O_MPWROUT	UNIT16	number	1	MultiPac power output (low word) (the above two words make up the MultiPac power output in watts)
O_MPWRCAP2	UNIT16	number	1	MultiPac power capacity (high word)
O_MPWRCAP	UNIT16	number	1	MultiPac power capacity (low word) (the above two words make up the MultiPac power capacity in watts)

Slave Modbus Memory Category Item Name Table (Default; user can modify data entries)

Data Identifier	Data Type	Data Units	Data Scale	Data Description
KEY_ID	INT16	number	1	Structure ID
I_EXT_STRT	UINT16	number	1	External Start Input
I_SPIN_RSRV	UINT16	number	1	Spinning Reserve Input

APS Settings Memory Category Item Name Table

Data Identifier	Data Type	Data Units	Data Scale	Data Description
KEY_ID	INT16	number	1	Structure ID
ActiveProfileSelector	UINT8 (15)	string		DLL that is used by the MultiPac manager
ManualProfileGroupId	INT16	number	1	Manual Profile Group ID
MaxTurbineNumber	INT16	number	1	Maximum Turbine Number
MultipacFrequency	UINT32	millisecond	1	Optimal MicroTurbine communication period
PingFrequency	UINT32	millisecond	1	Optimal pinging period while seeking unlocked MicroTurbines
DaqFrequency	UINT32	millisecond	1	Optimal Daq information retrieval period
ControlShutdownFlag	UINT8	number	1	Control program shutdown flag
MultipacMgrShutdownFlag	UINT8	number	1	MultiPac manager shutdown flag
MbMasterShutdownFlag	INT8	number	1	Modbus master shutdown flag
MbSlaveShutdownFlag	INT8	number	1	Modbus slave shutdown flag
CRMSintShutdownFlag	INT8	number	1	CRMS interface program shutdown flag
ParserShutdownFlag	INT8	number	1	Parser manager shutdown flag
ControlWatchdogTime	UINT32	millisecond	1	Control Watchdog timer value
MultipacMgrWatchdogTime	UINT32	millisecond	1	MultiPac manager Watchdog timer value
MbMasterWatchdogTime	UINT32	millisecond	1	Modbus master Watchdog timer value
MbSlaveWatchdogTime	UINT32	millisecond	1	Modbus slave Watchdog timer value
ParserWatchdogTime	UINT32	millisecond	1	Parser manager Watchdog timer value
CRMSintWatchdogTime	UINT32	millisecond	1	CRMS interface Watchdog timer value
DebugMode	UINT8	number	1	Debug mode flag
AdminPsswd	UINT8 (15)	string	—	Encrypted password
SAmodeConfigurable	INT16	number	1	Stand Alone configurable mode flag (set to 1 if Stand Alone mode is required to use dispatch sequence)

Group Commands Memory Category Item Name Table

Data Identifier	Data Type	Data Units	Data Scale	Data Description
GROUP_ID	INT16	number	1	Structure ID
time_stamp	INT32	millisecond	1	Packet transmission time
strcmd	INT16	number	1	Start command
pwrdmd	INT32	watt	1	Power demand
contr_cmd	INT16	number	1	Contactor command
rchena	INT16	number	1	Recharge enable flag
batchg	INT16	number	1	Battery charge flag
sys_utlcon	INT16	number	1	System utility connection
inv_sync	INT16	number	1	Inverter synchronization flag
inv_sync_z1	INT16	number	1	Inverter synchronization flag2
gc_enable	INT16	number	1	Grid Connect enable flag
inv_master	INT16	number	1	Turbine number for the inverter master
autorestart_time	INT32	second	1	Time for autorestart

Group Command Response Memory Category Item Name Table

Data Identifier	Data Type	Data Units	Data Scale	Data Description
GROUP_ID	INT16	number	1	Structure ID
time_stamp	INT32	millisecond	1	Packet transmission time
pwrout	INT32	watt	1	Output power
pwr_import	INT32	watt	1	Power imported
max_pwrdmd	INT32	watt	1	Maximum power demand
pwr_capacity	INT32	watt	1	Power capacity
contr_timeout	INT16	number	1	Timer to keep track of ON time (minimum power timeout)
GCInterlock	INT16	number	1	Grid Connect interlock flag
SAInterlock	INT16	number	1	Stand Alone interlock flag
inv_master	INT16	number	1	Turbine number of inverter master
strcmd	INT32	number	1	Start command
mpenab	INT32	number	1	MultiPac enable flag
ok_to_run	INT16	number	1	Ok to run flag
ok_to_load	INT16	number	1	Ok to load flag
syscon	INT32	number	1	System status
ia	INT16	amp	0.0625	Current Phase A
ib	INT16	amp	0.0625	Current Phase B
ic	INT16	amp	0.0625	Current Phase C
in	INT16	amp	0.0625	Current Neutral
total_curr	INT32	amp	0.0625	Total current
highest_locked_child	INT16	number	1	Highest locked turbine number
operating_hrs	INT32	time	time format	Operating hours
gc_wait_done	INT16	number	1	Grid Connect wait completion flag